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BENTHIC BIOLOGY. KANAWHA RIVER BASIN; NORTH CAROLINA, VIRGINIA, WEST VIRGINIA

Federal Water Pollution Control
Administration
Wheeling, West Virginia

1967

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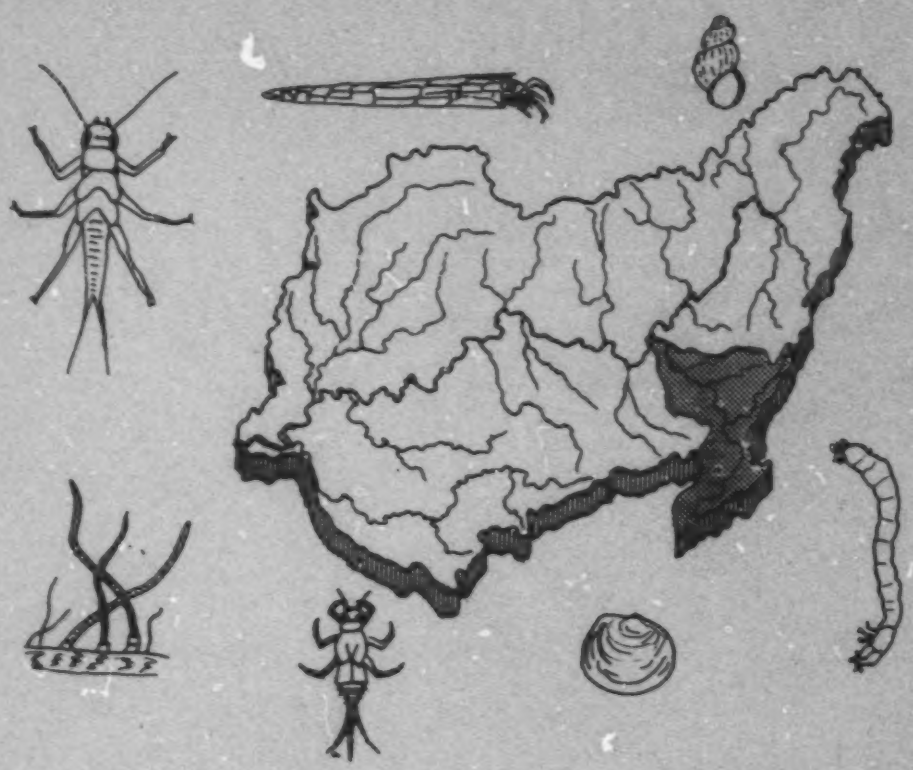
NORTH CAROLINA, VIRGINIA, WEST VIRGINIA



UNITED STATES DEPARTMENT OF THE INTERIOR
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OHIO RIVER BASIN PROJECT
WHEELING FIELD STATION

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BENTHIC BIOLOGY

KANAWHA RIVER BASIN

North Carolina, Virginia, West Virginia

Work Document No. 1

Aquatic Biology Unit
Laboratory Services Section
Wheeling Field Station
Ohio River Basin Project

OHIO RIVER BASIN REGION
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
UNITED STATES DEPARTMENT OF THE INTERIOR

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I. INTRODUCTION

Objectives and Scope of Study

The Wheeling Field Station of the Ohio River Basin Comprehensive Project, Federal Water Pollution Control Administration conducted a water quality study of the Kanawha River Basin during 1964. The field station performed physical, chemical and biological analyses and observations throughout the drainage area. This report deals with the biological studies conducted as a part of the Kanawha investigation.

The objectives of the biological study are (1) to define the aspects of pollution prior to intensive chemical appraisal of the water quality and (2) to establish a "base-line" of present biological conditions against which future changes can be measured.

The intent of this report is to document the results of the biological study and to function as a planning aid for water quality studies in the Kanawha River Basin.

The aquatic biology survey provides a gross analysis of the water quality in a given stream or section of stream. The biological data and descriptions delineate the areas capable of supporting aquatic organism associations typical of non-polluted water from those aquatic communities exhibiting a disrupted or altered benthos. An altered benthic community indicates environmental changes such as occurs with pollution of the habitat.

The results of this survey and related observations, together with other basic information, constitutes a base for the planning, formation and execution of a water quality survey.

The effects of pollution on aquatic life can be dramatic, as for example, the occurrence of a fish kill. The effects can also be demonstrated in more subtle ways. The effects of pollution on benthic organisms has been presented with the use of varying techniques and demonstrations by aquatic biologists in numerous water pollution reports. The use of biological phenomena in accessing water quality is an established and accepted methodology employed by water pollution investigating agencies. Homogeneously, this report presents the findings of the benthic biology studies conducted in the Kanawha River Basin in 1964.

The Kanawha Basin drains 12,300 square miles and has approximately 6,000 miles of streams. The Kanawha is the fourth largest basin in the Ohio River drainage.

The Kanawha River is formed by the confluence of the New and Gauley Rivers at Gauley Bridge, West Virginia, and flows 97 miles northwesterly to its mouth at Point Pleasant, West Virginia. Principal tributaries to the Kanawha are Coal River (96.0 miles long), Elk River (181.0 miles),

New River (341.0 miles), Bluestone River (77.5 miles), and the Greenbrier River (150.5 miles). The Kanawha River falls at an average rate of 1.2 feet per mile and the New River at an average rate of 9.2 feet per mile.

The Kanawha Basin is mountainous in character, and the elevation ranges from a high of over 5,000 feet in the headwaters in North Carolina to 538 feet at Point Pleasant, West Virginia.

The predominate land use in the basin is forestland and intermittent agricultural land consisting chiefly of pastureland.

The 1960 census of the Kanawha Basin was a total of 907,100. The highest concentration of the population is located in the chemical industrialized Kanawha Valley.

The Kanawha River Basin is composed of a variety of stream habitats. Many of the headwater tributaries are considered trout streams, reflecting their pristine water quality. Progressively downstream, with longitudinal succession occurring naturally, the life zone habitats change with gradient, temperature, basic fertility, physical alteration, etc.

Pollution, in different forms, alters the habitats mildly to severely within the basin. The lower Kanawha River is an example of severe degradation of the aquatic habitat by pollution.

The aquatic biology field studies were designed to adequately sample representative habitats throughout the basin.

II. SUMMARY OF FINDINGS AND CONCLUSIONS

The Kanawha River drainage sub-basins discussed below are shown in Figure 1.

The biota of the New River Basin reflects extreme variations in water quality. The majority of the streams sampled support a variety of organisms indicative of "healthy" water quality conditions. There are exceptions at which the biota reflect degraded conditions. A summary of the biological studies follows.

The South Fork of the New River, below Boone, North Carolina, consists of a biota associated with domestic pollution. The station at Jefferson, North Carolina, located downstream of the Boone station, supports a well-balanced aquatic biota, reflecting recovery conditions.

Chestnut Creek, below Galax, Virginia; Peak Creek, below Pulaski, Virginia; Stroubles Creek, below Blacksburg, Virginia; and East River, below Bluefield, West Virginia, are characterized by aquatic fauna associated with degraded water quality. East River, near its mouth to the New River, supports a variety of organisms indicative of healthy water quality conditions.

The fourteen sampling stations located throughout the entire length of the main stem of the New River is represented by a diverse and abundant aquatic fauna. The biota of the New River is not typical of degraded conditions.

The fauna of the Bluestone River reflects severe degradation in the headwater area near Falls Mills, Virginia, and Bramwell, West Virginia. An industrial outfall is located above these stations. Sampling points downstream are represented by aquatic biota associated with healthy water quality conditions. The biota near the mouth of the Bluestone indicates recovery.

Brush Creek, a tributary of the Bluestone, is characterized by organisms associated with domestic pollution.

The Greenbrier River biota, for the most part, consists of organisms intolerant of pollution and indicative of good water quality. There are, however, short stretches of the main stem Greenbrier affected by tannery wastes. The biota of these polluted zones consists of pollution-tolerant organisms.

The Gauley River Basin streams support a variety of organisms. The major tributaries of the Gauley are the Williams River, Cranberry River, and Cherry River. The stations sampled on these streams were inhabited by aquatic fauna associated with healthy conditions. The biota of the Meadow River, near East Rainelle, West Virginia, indicates degraded conditions. Farther downstream, near Nallen, West Virginia, the stream supports a variety of organisms, most of which are pollution-sensitive.

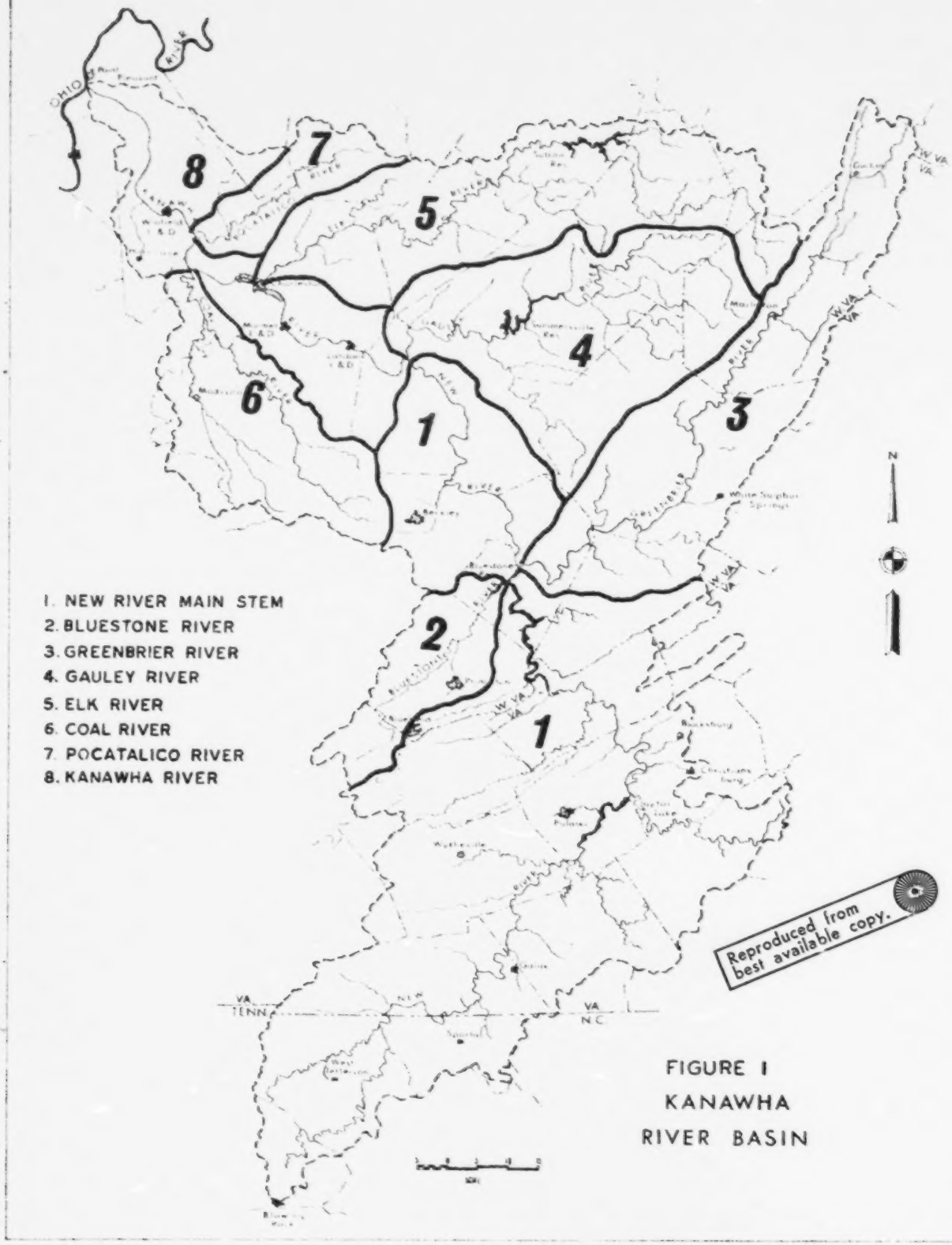

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FIGURE 1
KANAWHA
RIVER BASIN

The main stem of the Gauley River supports a biota of variety and of intolerant forms. The upper reaches of the Gauley is affected by silt and coal settlings, tending to smother bottom associated organisms. However, where stable substrates are available, the intolerant forms are observed.

The Elk River Basin biota is diverse and is represented by intolerant forms, indicating healthy water conditions. The fauna sampled below Clendenin, West Virginia, suggests a degree of degradation. The station near the mouth of Elk River at Charleston consists of pollution-tolerant organisms.

The Coal River Basin biological studies reflect extremes in water quality. Many of the tributaries are subjected to acid mine drainage. The most severe is Pond Fork, and it is sparsely populated with aquatic organisms. Clear Fork, above Whitesville, West Virginia, is devoid of bottom dwelling organisms. The biota of Coal River, below Seth, indicates organic enrichment. Stations downstream to the mouth of Coal River support pollution-sensitive forms. Near the mouth of Coal River the biota is affected by the polluted water of the Kanawha. A major tributary of the Coal, the Little Coal, supports sensitive forms associated with good water quality.

The biota of the upper portion of the Pocatalico River, a tributary of the Kanawha, is sparse but consists of sensitive forms. The physical characteristics of this section of the stream are that of silt loading and unstable substrate. The biota of the lower portion of the Pocatalico consists of pollution-tolerant organisms indicating a degraded condition. The backwater area near the mouth is affected by the polluted Kanawha River.

The benthic biology studies summarized here compliment and support the conclusions exhibited in Figure 8. The problem areas indicated were independently concluded by study of the chemical and bacteriological data.

The biota of the Kanawha River is composed of pollution-tolerant forms. Pollution-sensitive forms were observed at only two of the twelve sampling points. These were at Gauley Bridge and at London. The sampling station between these two, at Montgomery, consists of a pollution-tolerant biota. Below London, the biota consists of bloodworms and sludgeworms, characteristic of degraded conditions. Severe degradation below Blaines Island (Charleston) eliminates bottom associated organisms. The remaining stations to the mouth of the river consist of only pollution-tolerant forms.

Paint Creek and Cabin Creek, minor tributaries to the Kanawha, were sampled near their mouths, and both are characterized by pollution-tolerant forms. Both streams are affected by pollution from mining operations.

III. METHODS AND TECHNIQUES

Benthos Role in Water Pollution Surveys

The primary objective of a biological survey as part of the comprehensive project is to determine the water quality using aquatic organisms as an index. The role of benthic organisms in the study of water pollution has been well documented.

The biological characterization of any given stream is best accomplished by a study of the macro-invertebrate fauna. The aquatic community includes three major groups: the nekton or free swimmers, the plankton or drifters, and the benthos or bottom associated organisms. Since fish are transient in nature and plankton are moved about by currents, the benthos is best suited for study to determine prevailing water quality conditions. Bottom dwelling organisms exhibit a pronounced response to pollution, have a sufficiently long life cycle to prevent response to intermittent relief from pollution, and lack a means of rapid locomotion thus prohibiting extended migrations. Because of these qualities, bottom-dwelling organisms reflect conditions at the sampling point for an extended period of time.

Field and Laboratory Techniques

Whenever possible, samples are collected from riffle areas. It has been demonstrated that the degree and extent of pollution in a stream can be determined accurately by reference to the macro-invertebrate fauna, particularly that found in the riffles. Also particulate organic matter and silt tends to settle out in pools creating an unfavorable habitat. Samples collected from such areas do not often reflect the true condition of the stream.

The number of samples collected at any one station is left to the judgment of the biologist. Generally, two to three cross section samples per station (or sample site) are collected, depending on the size of the stream. Published reports have shown that only two square-foot samples are necessary to be reasonably certain of obtaining representatives of the principal groups of organisms present.

Samples were collected with the Surber sampler, Peterson dredge or Ekman dredge depending on the habitat or substrate at the sampling point. The material collected is washed, sieved (when collected with a dredge), and placed in quart jars with preservative. The samples are transported to the station laboratory for enumeration and identification of the aquatic organisms. All organisms are identified to the family taxonomic level, with exception of the sludge worms which are identified only to the class taxonomic level. The individual groups of organisms are classed as intolerant, tolerant and very tolerant based upon their response to pollution. This classification is based on known tolerances of various groups as reported in the literature, and upon personal observations of various benthic associations encountered in both polluted and unpolluted waters.

IV. RESULTS OF BENTHIC SAMPLING

A total of 125 stations were established and studied throughout the Kanawha River Basin. Table 1 lists the location and physical description of each station. Figure 9, at the terminus of this report shows the station locations and types of samples collected during the study. Benthic samples were collected at 103 of the 125 stations. The remainder were examined qualitatively.

The physical composition, as described in Table 1, of the substrate and habitat available affects the number and kinds of organisms present. A knowledge of the habitat normally occuppied by various organisms and the effect of habitat changes upon these organisms is as important as the direct effects of water quality changes. Recognition of this ecological principle is important to the conclusions developed for a particular section of stream. The benthic association observed and the habitat analysis must both be given equal consideration when evaluating the pollutional status of a given area.

Tables 2 through 10 lists the organism composition of each station sampled. The table includes the stream, station number, number of square foot samples collected, number of individuals for each taxonomic group collected, total number of organisms collected, average number per square foot, number of varieties, and percentages of pollution tolerant groups.

The pollution tolerant groups, for demonstration purposes, are called Class I, II and III. The tolerance groups, as defined for this report are: I) intolerant, or organisms unable to withstand polluted conditions; II) tolerant, or organisms capable of withstanding moderate amounts of pollution and III) very tolerant, or organisms with the capability to withstand severe polluted conditions. The tolerant and very tolerant groups have a wide range of tolerance levels, and with increased pollution these groups are able to replace the intolerant forms in the biota.

The variety diversity and percentages of the tolerance groups are represented in Figures 2 through 7 by bar graphs and histograms respectively. These graphic figures are shown for each station on a schematic drawing of the Kanawha River sub-basins. It is noted that a reduction in the number of varieties generally is accompanied by an increase in the percentage of tolerant and very-tolerant forms.

A total of 51 different zoobenthic forms were identified from the samples collected in the Kanawha River Basin. Forty-one families of seven orders were identified of the aquatic insects. The remaining forms included clams, snails, flatworms, annelid worms, crayfish, sowbugs and scuds. The Kanawha River sub-basins and the number of varieties for each are: New River Basin, 38; Greenbrier River Basin, 30; Bluestone River Basin, 19; Gauley River Basin, 24; Elk River Basin, 27; Coal River Basin, 21; Pocatalico River Basin, 9; and the mainstem Kanawha River Basin, 13.

Correspondingly, those basins with the fewer varieties of zoobenthic forms identified are the ones characterized as having greater pollution problems.

Figure 8, showing the problem areas in the Kanawha Basin, is based on the results of chemical and bacteriological analyses. The effects of siltation and other physical changes is not easily detected by these tests.

Following is a summary of the biological observations in the Kanawha Basin.

Upper New River Basin (Tables 2 & 3; Figures 2 & 2a)

The benthic fauna of the North and South Forks of New River, except for one area, is represented by organisms typically associated with water free of pollution. The lone exception in the upper portion of the basin is on the South Fork below Boone, North Carolina. Leeches and sludgeworms, organisms very tolerant of organic pollution, made up 73% of the total number of organisms collected. The station at Jefferson, North Carolina, located several miles downstream of Boone, supports a variety of intolerant forms.

Most of the major tributaries of the upper New River in North Carolina and Virginia have a rich and varied benthic faunae. Reed Creek, Big Reed Island Creek, Little River (Virginia), Walker Creek, and Wolf Creek support fauna typical of pollution-free water.

Chestnut Creek below Galax, Virginia, has a benthic fauna dominated by tolerant and very tolerant forms. Chestnut Creek receives domestic pollution from Galax.

The benthic fauna of Peak Creek below Pulaski, Virginia, is severely reduced, indicating a possibility of toxic materials.

Stroubles Creek below Blacksburg, Virginia, has a benthic fauna dominated by tolerant forms, indicating moderate pollution.

East River below Bluefield, West Virginia (Station 26) has a fauna of bloodworms and sludgeworms, reflecting degraded water quality. The Bluefield sewerage treatment plant is located immediately above the sampling station. East River, near its mouth to the New River and approximately 15 miles downstream of the above station, supports a variety of benthic organisms dominated by intolerant forms.

The New River main stem was sampled at fourteen different locations throughout its length. In general, the biota of the New River is not typical of degraded conditions. Two New River stations have a reduced number of varieties, indicating alteration. The station at Ivanhoe, Virginia, (Station 10) was characterized by abnormal siltation. A

quarry-type operation was located upstream. The number of varieties was reduced at Stations 17 and 17a, both located below Claytor Dam. This reduction of varieties may reflect molar effects of current or water quality effects of the reservoir drawoffs.

Bluestone River Basin (Table 5, Figure 3)

The benthic fauna of Bluestone River below Falls Mills, Virginia, (Station 30) is typical of an aquatic environment severely polluted by organic wastes. The variety of organisms was reduced to two, and sludgeworms averaged 400 per square foot. An industrial outfall is located near the Virginia-West Virginia border. The stations (31, 32, 33a) sampled further downstream show a reduction of the effect of this pollution as the number of varieties increases and the tolerance group dominance shifts from the very tolerant to intolerant. Figure 3 graphically portrays this biological measurement.

Brush Creek, a tributary of Bluestone River, has a reduced benthic fauna and receives domestic waste from Princeton, West Virginia.

Greenbrier River Basin (Table 4, Figure 3)

With the exception of two short portions, the benthic biota of the Greenbrier River Basin represents a water quality free of pollution.

The fauna of the East Fork below Frank, West Virginia, (Station 36) consisted entirely of a few bloodworms. An outfall from a tannery at Frank severely degraded the West Fork and a short stretch of the Greenbrier River (Station 38) below the junction of the East and West Forks. The biota of the Greenbrier River at Cass (Station 39) consists of intolerant forms and reflects no ill effects from the tannery wastes. The West Fork fauna includes forms similar to those inhabiting the unpolluted portion of the East Fork above Frank.

The benthic fauna below Marlinton, West Virginia, is deleteriously affected by another tannery outfall in Marlinton. The benthic composition at Station 42 is dominated by tolerant and very tolerant forms. A linear stratification was observed at this station. Further downstream (3.5 miles) at Station 44, the benthic fauna returns to similar composition as above Marlinton.

The benthic fauna of Howard Creek (Station 47) reflects organic pollution from upstream communities.

The remainder of the Greenbrier Basin samples are typical of aquatic communities free of pollution.

Gauley River Basin (Table 6, Figure 4)

The headwater tributaries of the Gauley River, namely Williams, Cranberry, and Cherry Rivers (Stations 57, 59, 60) support benthic fauna

typical of mountain streams free of pollution. Laurel Creek contributes pollution from mining operations to Cherry River but apparently has little effect on the Cherry River.

The benthic fauna of Meadow River below East Rainelle, West Virginia, (Station 62) indicates conditions favorable to very tolerant forms. Further downstream, the biota of Meadow River (Station 63) is reduced in total numbers and variety of forms, but has a highest percentage of intolerant forms.

The main stem of the Gauley River is represented by a benthic fauna associated with unpolluted water where the substrate is suitable for aquatic life development. The Gauley River is subject to siltation from runoff and fine particles from coal washery operations. Station 58 is characterized with a silted substrate and the benthos is dominated by the tolerant class. Station 61 has a reduction of organisms and varieties. This section of the Gauley is subject to coal washery products and intermittent amounts of acid from mine drainage areas. Station 64, approximately 25 miles downstream of Station 61, has a typical clean water benthic community

Elk River Basin (Table 7, Figure 5)

The benthic fauna of the Elk River Basin shows similarity to the Greenbrier River and headwaters of Gauley River. The varieties and numbers between the stations are fairly consistent. With the exception of Stations 88 and 90, the benthos is dominated by the intolerant group.

Station 88, below Clendenin, West Virginia, indicates degradation of the water quality. Oily deposits were observed in the sampling area. The benthos is reduced in both number and variety. The sampling point at Station 90, near the mouth of the Elk River, is influenced by the back-water of the Kanawha River. This station has a poor substrate, consisting of coal particles and sand.

Coal River Basin (Table 8, Figure 6)

The benthic data of the Coal River is erratic, reflecting extremes in water quality. Many of the tributaries in the basin are subject to acid drainage from mining operations.

Clear Fork (Station 95) is devoid of benthic organisms and is subject to acid drainage.

The benthos of the Coal River below Seth, West Virginia, is dominated by tolerant forms. The benthic composition of the Coal River gradually shifts to intolerant dominance progressively to its mouth. Near the junction with the Kanawha River, the benthos is dominated by tolerant and very tolerant forms. Similar to the Elk, this last sampling point on the Coal River is influenced by the backwater of the Kanawha River.

Pond Fork, a tributary of the Coal, is subject to severe acid drainage. Stations 104, 106, and 107 reflect this condition in reduced numbers and varieties of benthic forms.

The benthos of Little Coal River consists of a variety of intolerant forms.

Kanawha River Main Stem Basin (Table 9 & 10; Figure 7)

The Kanawha River is canalized for approximately 91 miles and therefore, the habitat differs greatly from the remainder of the basin. The Kanawha River habitat favors the development of the more tolerant forms. As Figure 7 shows, these forms dominate the benthic composition at all the sampled stations. However, the upper stations (65, 67, 69 and 71) have a greater number of varieties than those below Marmet.

The severe polluted conditions below the South Charleston industrial complex has eliminated the benthos at Stations 93 and 113.

The benthic composition of the Kanawha River stations consisted almost entirely of tolerant midge larvae and aquatic worms.

The substrate of the Kanawha consists of sludge, coal fines and sand. A suitable substrate for benthic development is rarely encountered in the Kanawha River.

V. GENERAL DISCUSSION OF FISH LIFE

Although fish studies have not been conducted by project personnel in this study, a general discussion drawn from state agency reports is offered.

The New, Greenbrier, Gauley and Elk Rivers possess similar fish populations. Generally, these basins began with put-and-take trout streams succeeding downstream to bass, catfish, walleye and other warm-water populations. In those sections cited as being pollution problems, it is assumed that fish populations are altered accordingly.

Much of these basins lie in forestland and include heavily used recreation areas in which fishing is a major activity.

The Coal River Basin has had a history of coal mining activities and the fish population has responded to the associated pollution. It is indicated, however, by state personnel, that alleviation of the washery problem has had beneficial results on the fish population. Apparently the warm water populations are recovering in the lower portions of the Coal.

The Kanawha River fish population is dominated by tolerant species such as carp and bullheads. Above Charleston, West Virginia, however, game fish catches are not rare. Large river fishes, such as drum, buffalo, and flathead catfish are common.

It is worthwhile to include a compilation of fish kills that occurred during the latest year of complete records. Table 11 lists the 1966 recorded fish kills in the Kanawha River Basin.

The benthic sampling station nearest the fish kill location is also indicated in the table.

TABLE I STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
South Fork - New River - Boone, N. C.	1	R	S	< 1	C. Gravel Sand	X			Headwater Section
South Fork - New River - Perkinsville, N. C.	2	R	S	< 1	Rubble Sand Silt			X	Sewage Pollution
South Fork - New River - Jefferson, N. C.	3	R	S	< 1	Rubble Sand	X			
North Fork - New River - Creston, N. C.	4	R	S	< 1	C. Gravel Sand Silt	X			Headwaters
North Fork - New River - Warrensville, N. C.	5	R	S	< 1	Rubble Gravel	X			
New River - Mouth of Wilson, N. C.	6	P	P	4	F. Gravel Sand Rock		X		Shifting Substrate
Little River - Sparta, N. C.	7	R	S	< 1	Rubble Gravel Silt	X			High Gradient
New River - Galax, Virginia	8	R	S	< 1	Bedrock C. Gravel Sand	X			Wide Section of River
Chestnut Creek - Galax, Va.	9	R	S	< 1	C. Gravel Sand		X	X	Sewage Pollution

KEY:

Sampling Area
P = Pool
R = Riffle

Type Sampler
P = Petersen dredge
E = Ekman dredge
S = Surber square foot
Q = Qualitative sample

Benthic Fauna Dominance
- No organisms present

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
New River - Ivanhoe, Virginia	10	R	S	< 1	Bedrock Silt	X	X		Poor Substrate, Abnormal Siltation
Reed Creek - Grahams' Forge, Va.	11	R	S	< 1	Rock Rubble	X			
Big Reed Island Creek - Allisonia, Va.	12	R	S	< 1	Rubble Gravel Sand	X			
New River - Allisonia, Va.	13	P	P	4-6	Rock C. Gravel Sand		X		Headwaters of Claytor Reservoir
Peak Creek - Pulaski, Va.	14	R	S	< 1	Rock Rubble Gravel		X	X	Sewage Pollution
Little River - Floyd, Va.	15	R	S	< 1	Rubble Gravel	X			
Little River - Snowville, Va.	16	R	S	< 1	Rock Rubble Sand	X			
New River - Claytor Dam, Va.	17	P	P	4-6	Sand Silt Clay		X	X	Poor Substrate
New River - Radford, Va.	17a	R	S	< 1	Rock Rubble Gravel		X	X	
New River - Below Radford, Va.	18	P	P	3-18	Bedrock Gravel Sand		X	X	Deep Pool
Stroubles Creek - Blacksburg, Va.	19	P	P	3-18	Rock Rubble Gravel		X		Sewage Pollution
New River - McCoy, Va.	20	P	P; E	2-4	Rock Gravel Sand	X	X		
Walker Creek - Bane, Va.	21	R	S	< 1	Rubble Gravel Sand	X			

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Walker Creek - Mechanicsburg, Va.	21a	R	S	1	Rubble Gravel	X			Very Productive
New River - Pearisburg, Va.	22	P	P	3-7	Gravel Sand	X			
New River - Below Pearisburg, Va.	23	P	Q	4-7	Rock Gravel Sand		X		Tannery Outfall Upstream
Walk Creek - Narrows, Va.	24	R	S	< 1	Rock Rubble Gravel	X			
New River - Glen Lyn, Va.	25	P	P	3-8	Rock Gravel Sand			X	Shoreline Areas With Organic Silt
East River - Bluefield, W. Va.	26	R	S	< 1	Gravel Clay Silt		X	X	
East River - Glen Lyn, Va.	27	R	S	< 1	Gravel Rubble Sand	X			
Bluestone River Headwaters	28 & 29	R	S	< 1	Sand Rock		X	X	Poor Substrate
Bluestone River Falls Mills, Va.	30	R	S	< 1	Gravel Organic Silt			X	Industrial Pollution
Bluestone River Bramwell, W. Va.	31	R	S	< 1	Rock Rubble Gravel		X		
Bluestone River Spanishburg, W. Va.	32	R	S	< 1	Gravel Rubble Rock	X	X		
Brush Creek - Gardner, W. Va.	33	R	S	< 1	Silt Sand Gravel		X		Sewage Pollution

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Bluestone River Above Bluestone Reservoir	33a	R	S	< 1	Rubble Rock Gravel	X			
New River - Bluestone Dam, W. Va.	34	R	S	< 1	Rock Rubble Gravel	X			Wide Section Below Dam
East Fork - Greenbrier River, Bartow, W. Va.	35	R	S	< 1	Rubble Gravel Rock	X			
East Fork - Greenbrier River, Frank, W. Va.	36	R	S	< 1	Rubble Rock Gravel		X		Tannery Pollution
West Fork - Greenbrier River, Durbin, W. Va.	37	R	S	< 1	Rock Rubble Gravel	X			
Greenbrier River Below Junction of Forks	38	R	S	< 1	Rock Rubble		X		
Greenbrier River At Cass, W. Va.	39	R	Q	2	Rubble Gravel	X			
Deer Creek, Cass, W. Va.	40	R	S	< 1	Rubble Rock Gravel		X		
Greenbrier River Above Marlinton, W. Va.	41	R	S	< 1	Rubble Gravel	X			
Greenbrier River Marlinton, W. Va. (East Shore)	42	R	S	< 1	Rubble		X		Tannery Pollution
Greenbrier River Marlinton, W. Va. (West Shore)	42	R	S	< 1	Rubble		X		Tannery Pollution
Knapp Creek Marlinton, W. Va.	43	R	S	< 1	Rubble Rock Gravel	X	X		

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Greenbrier River Buckeye, W. Va.	44	R	S	< 1	Rubble	X			
Greenbrier River Caldwell, W. Va. (Above Howard's Creek)	46	R	S	< 1	Rubble Gravel	X			
Howard's Creek Near Mouth	47	R	S	< 1	Gravel Rubble		X		
Greenbrier River (Below Howard's Creek)	48	R	S	< 1	Rubble	X			
Greenbrier River Alderson, W. Va.	49	R	S	< 1	Rubble Rock Gravel	X			
Greenbrier River Hillsdale, W. Va.	50	R	S	< 1	Rock Rubble	X			
New River - Hinton, W. Va.	51	R	S	< 1	Rock Rubble	X			
New River - Meadow Creek	51a	R	Q	2	Rubble Gravel	X			Wide Section
New River - McCreedy, W. Va.	52	R	S;	< 1	Rubble,				Deep Channel
		P	P	5-16	Gravel	X			
					Rock, Gravel	X	X		
Piney Creek - Fitzpatrick Park	53	R	S	< 1	Gravel	X			
Piney Creek - McCreedy	54	R	S	< 1	Rock Rubble Gravel		X	X	Sewage Pollution
New River - Gauley Bridge, W. Va.	56	P	P	4-25	Bedrock Rock Rubble Gravel	X	X	X	Large, Deep Pool
Williams River - Dyer, W. Va.	57	R	S	< 1	Rock Rubble Gravel	X			

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Gauley River - Camden, W. Va.	58	P	P	1-2	Sand Rock Gravel		X		Poor Substrate, Siltation
Cranberry River Above Richwood, W. Va.	59	R	S	< 1	Rock Rubble	X			Headwater Station
Cherry River - Fenwick, W. Va.	60	R	S	< 1	Rock Rubble Gravel	X			
Muddlety Creek	60a	R	Q	1	Silt Sand	None Observed			Coal Fines
Muddlety Creek	60b	R	Q	1	Silt Rock Gravel	X			
Muddlety Creek At Mouth	60c	R	Q	1	Rock Rubble	X			
Gauley River Summersville, W. Va.	61	R	S	< 1	Rock Rubble Gravel	X			Presently Summersville Reservoir
Meadow River - East Rainelle, W. Va.	62	P	S	< 1	Sand Silt Gravel		X	X	Poor Substrate
Meadow River Nallen, W. Va.	63	R	S	< 1	Bedrock Rubble	X			
Gauley River Belva, W. Va.	64	R	S	< 1	Rubble Gravel	X			
Kanawha River - Gauley Bridge, W. Va.	65	P	P	8-12	Sand Silt		X		
Kanawha River Above Montgomery	66	P	P	12-25	Silt			X	
Kanawha River - Montgomery, W. Va.	67	P	P	12-25	Sand Silt			X	Industrial Pollution

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	
Paint Creek - Hansford, W. Va.	68	P	P	1	Sand Gravel		X		Mine Drainage
Kanawha River - London, W. Va.	69	P	P	4-15	Rock Rubble Sand			X	
Cabin Creek - Near Mouth	70	R	P	1	Rock Silt		X		Domestic Pollution
Kanawha River - Chelyan, W. Va.	71	P	P	16-33	Rock Silt Gravel			X	Industrial Pollution
Kanawha River At Charleston	73	P	P	12-15	Rubble Gravel Sand			X	
Elk River - Bergoo, W. Va.	74	R	S	< 1	Rock Rubble	X			Headwater Station
Back Fork of Elk River - Webster Spring, W. Va.	75	R	S	< 1	Rubble Rock Gravel	X			High Gradient Tributary
Elk River Centralia	76	R	S	< 1	Rock Rubble	X			
Right Fork Holly River Near Mouth	78	R	S	< 1	Rubble Rock Sand	X	X		Headwaters of Sutton Reservoir
Left Fork Holly River Near Mouth	79	R	S	< 1	Rubble Rock	X			Headwaters of Sutton Reservoir
Holly River	80	P	Q	1	Gravel Rubble		X		Frequently Inundated by Sutton Reservoir
Elk River - Gassaway, W. Va.	82	R	S	< 1	Rock Rubble Sand	X	X		Shifting Bottom
Birch River Herold, W. Va.	83	R	S	< 1	Rubble Gravel	X			
Elk River Ivydale, W. Va.	84	R	S	< 1	Rubble Rock	X			

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Buffalo Creek Dundon	85	R	Q	3	Rubble Gravel		X		Coal Fines
Elk River - Queen Shoals, W. Va.	86	R	S	3	Rubble Rock	X			
Big Sandy Creek - Clendenin, W. Va.	87	R	S	3	Gravel Rubble Sand	X			
Elk River - Blue Creek, W. Va.	88	R	S	3	Rubble Gravel			X	Industrial Pollution
Blue Creek	89	R	Q	1.5	Rubble	None Observed			Rocks Stained Red
Elk River - Charleston, W. Va.	90	P	P	4-8	Sand Gravel			X	Coal Fines In Substrate
Kanawha River - Charleston, W. Va.	91	P	P	10-15	Sand Silt			X	
Kanawha River Below Blaines Island	92	P	E	5-18	Sludge Sand			X	Coal Fines; Industrial Pollution
Kanawha River - St. Albans, W. Va.	93	P	P; E	18-20	Sludge Sand	---	---	---	No Organisms Collected
Marsh Fork Above Whitesville, W. Va.	94	R	S	< 1	Rubble Gravel	X			
Clear Fork Above Whitesville, W. Va.	95	R	S	< 1	Rubble Gravel	None Observed			Acid Water
Coal River Sylvester, W. Va.	96	R	S	< 1	Rubble Gravel	X			
Coal River Above Seth	97	R	Q	1	Rubble	X			
Laurel Creek - Seth	98	R	Q	.5	Rubble	None Observed			Silt

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Coal River - Seth, W. Va.	99	R	S	< 1	Rubble Gravel		X		
Coal River - Racine	100	R	Q	1	Rubble	X			Silt
Coal River - Braunland, W. Va.	101	R	S	< 1	Rubble Rock	X	X		
Pond Fork	102	R	Q	1	Gravel	None Observed			Acid Water
Pond Fork	103	R	Q	1	Gravel	None Observed			Receives Acid Slugs
Pond Fork Above Van, W. Va.	104	R	S	3.5	Rubble Rock Silt	None Observed			Acid Slugs
Pond Fork Below Van, W. Va.	106	R	S	< 1	Rubble Gravel Sand	---	---	---	Acid Slugs
Pond Fork Polk, W. Va.	107	R	S	< 1	Rubble Gravel Silt	X	X		
Spruce Fork Route 119	108	R	S	< 1	Rubble Rock	X			
Little Coal River Rock Creek	109	R	S	< 1	Rubble Rock Gravel	X	X		
Little Coal River Near Mouth	110	R	S	< 1	Rubble Gravel	X			
Coal River Below Junction With Little Coal	111	R	S	< 1	Rubble Rock Gravel	X			
Coal River Near Mouth	112	P	E	8	Sand Gravel			X	Coal Fines
Kanawha River Mile Point 41.6	113	P	P	15-20	Sludge Coal Gravel				No Organisms Collected
Pocatalico River Cicerone, W. Va.	114	R	S	< 1	Gravel Sand		X		

TABLE I (continued) STATION DESCRIPTION - Kanawha River Basin

STATION	STA. NO.	SAMPLING AREA	TYPE SAMPLER	DEPTH (In Feet)	SUBSTRATE	BENTHIC FAUNA DOMINANCE INTOL.	TOL.	V. TOL.	COMMENTS
Pocatalico Creek Above Mouth	115	R	Q	2.5	Sand Silt	X			
Pocatalico River Sissonville, W. Va.	116	R	P	< 1	Sand Gravel		X		Poor Substrate
Pocatalico River 5 Miles Above Mouth	117	P	E	7-8	Silt			X	
Pocatalico River Mouth	118	P	P	15	Sludge	---	---	---	No Organisms Collected
Kanawha River Mile 37	119	P	P	16	Coal Fines Sludge Clay	None Observed			
Kanawha River Mile 32	120	P	E	16	Oily Sludge			X	Four Organisms Collected
Hurricane Creek Above Mouth	121	R	Q	.5	Gravel		X		
Kanawha River Mile 25	122	P	E; P	6-12	Gravel Sand Debris			X	
18 Mile Creek Above Mouth	123	R	Q	.5	Rock Gravel	X			
Tributary to Kanawha Above Leon	124	R	Q	.5	Rock Gravel	X			
Kanawha River Mile 10	125	P	E	10-13	Sand Silt Sludge			X	
Kanawha River Pt. Pleasant, W. Va.	126	P	E; P	15-20	Coal Gravel Sand			X	

Table 2. COMPOSITION and CLASSIFICATION of NEW RIVER BENTHIC SAMPLES, 1964

NEW RIVER BASIN MAIN STEM — Station	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Hydropsychidae	Hydropsychidae	Hydroptilidae	Leptoceridae	Psychomyiidae	Rhyacophilidae	Perlidae	Pteronarcidae	Nemouridae	Taeniopterygidae	Isonychiidae	Heptageniidae	Baetidae	Ephemerellidae	Siphlonuridae	Gilled Snails Pleuroceridae	Clams Sphaeriidae	CLASS II: Dobsonflies Corydalidae	Leptoceridae	Brachycentridae	Limnephilidae	Molannidae	Odontoceridae	Polycentropodidae	Beetles Elmidae	Riffle Beetles Psephenidae	Crayfish Astacidae	Isopods Asellidae	Scuds Amphipoda	Fingernail Clams Sphaeriidae	Snails Pulmonata	Planarians Turbellaria	Midge Flies Chironomidae	Other Flies	Worms Oligochaeta	CLASS III: Leeches Hirudinea	Aquatic Worms Nematoda	Total Number	No./Sq. Ft.	Variety of Forms	% CLASS I	% CLASS II	% CLASS III
South Fork - New River	1	2		130				19	3		11			101				6									1	2							3	4			307	153	11	96	4	0
South Fork - New River	2	2																8														3		4	80			11	350	357	178	7	1	95	73
South Fork - New River	3	2		70		1			2		23	3	16					36														8			3		5			165	82	11	90	10	0
North Fork - New River	4	2		188	66			3	1	1	90			2				70				1				1	5							95					509	254	13	70	30	0
North Fork - New River	5	2	1	66					3	1	96	95	60	1				60									10								5	2				435	218	13	83	17	0
New River - North	6	3		1	1						36		10					13														98			44			98		280	73	9	18	56	26
New River	8	3		86					1		53		13					118		8			1		15							4			19		11		5	276	139	18	77	21	2
New River	10	3		8							19		6												1								11		35				4	74	24	7	36	59	6
New River	13	3		9	1	3					7	4		4											32		1				10			26	72			87	255	127	13	11	55	34

NEW RIVER BASIN MAIN STEM — Station	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Helicopsychidae	Hydropsychidae	Hydroptilidae	Leptoceridae	Psychomyiidae	Rhyacophilidae	Perlidae	Pteronarcidae	Nemouridae	Taeniopterygidae	Isonychiidae	Heptageniidae	Baetidae	Ephemerellidae	Siphlonuridae	Gilled Snails Pleuroceridae	Clams Sphaeriidae	CLASS II: Dobsonflies Corydalidae	Leptoceridae	Brachycentridae	Limnephilidae	Molannidae	Odontoceridae	Polycentropodidae	Beetles Elmidae	Riffle Beetles Psephenidae	Crayfish Astacidae	Isopods Asellidae	Scuds Amphipoda	Fingernail Clams Sphaeriidae	Snails Pulmonata	Planarians Turbellaria	Midge Flies Chironomidae	Other Flies	Worms Oligochaeta	CLASS III: Leeches Hirudinea	Aquatic Worms Nematoda	Total Number	No./Sq. Ft.	Variety of Forms	% CLASS I	% CLASS II	% CLASS III
New River	17	3																												6	51	86	3	3	188				160	630	166	6	0	63	37
New River	17a	3																13													4	11		8	185			1	183	311	203	6	4	47	49
New River	20	3									49							248		4	12		4	4	16					950	36	179		20			4	300	1,596	492	12	16	61	19
New River	22	3		1							351		7					1					3		11						20		1	116				63	572	190	9	63	36	11
New River	25	3		1							45		1					39							1		1				17	1	10	5			2	387	491	160	13	80	8	12
New River	36	3		749					1		85		15	5				37		3									2		23	15	93	57		0		1	1,087	332	15	81	19	0
New River	51	2		99					5		97		59	14				172		9					60		1					4		14		0		2	511	257	11	82	18	0
New River	52	6		49					4		85	33	184	3	9	15				1		1	9		87	1				1	130	270	1	37				139	1,280	214	19	84	65	11
New River	55	3		4			19				1	19			3								1		2						1	10	140	114			1	231	486	238	12	89	44	26

* = trace amounts

Table 3. COMPOSITION and CLASSIFICATION of NEW RIVER BASIN BENTHIC SAMPLES, 1964

NEW RIVER BASIN TRIBUTARIES — Stations	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Trichopteroidea	Hydropsychoidea	Hydroptilidae	Leptoceridae	Limnephilidae	Philopotamidae	Psychomyiidae	Stoneflies Nemouridae	Perlidae	Perlodidae	Pteronarcyidae	Mayflies Baetidae	Ephemeridae	Heptageniidae	Riffle Midges Orthocladiinae	Ballaenomidae Corydalidae	Alderflies Sialidae	Snipe Flies Rhagionidae	Gill Snails Pleurocerinae	CLASS II: Damselflies Coenagrionidae	Beetle Larvae Dryopidae	Elmidae	Gyrinidae	Psephenidae	Crayfish Astacidae	Scuds Gammaridae	Scuds Talitridae	Fingernail Clams Sphaeriidae	Snails Pulmonata	Flatworms Turbellaria	Worms Tubificidae	Midge Flies Chironomidae	Crane Flies Tipulidae	Black Flies Simuliidae	CLASS III: Leeches Hirudinea	Aquatic Worms Oligochaeta	Total Number	Total/Sq. Ft.	Variety of Forms	% CLASS I	% CLASS II	% CLASS III
Little River	7	2		3						2	1			9	15	41					18			4		1				3		3	1		4	105	52	13	85	11	4
Chestnut Creek	9	1		1										40																7		175			150	338	332	5	15	40	45
Reed Creek	11	2		139	5			8	7					85	10	18	5			4	2			22	1	1		12		186	56			511	255	16	41	39	0
Big Reed Island Creek	12	2		35							5	1	5	21	142	40		1			21			19	10					4			1	305	152	13	89	11	*
Peak Creek	14	2														1								3						2			5	11	5	4	10	45	45
Little River	15	2		91				20	23					151	1	19		2	1		102			66	1			2		2			2	476	238	14	85	15	*
Little River	16	2		91				46	4		11			135	1	5					49			54						10		15		419	209	11	81	19	0
Stroubles Creek	19	2			1																48		15		1		23	3	16	3	86		29	7	10	182	91	12	27	64	9
Walker Creek	21	2		6			5	2			9			19	5	70		2		1	64			115	9			1		1		29	1		9	368	184	16	53	45	2
Wolf Creek	24	2		41	9	3			1		9			41	4	45		2		4	117			19	10									3	399	199	14	90	9	1

NEW RIVER BASIN TRIBUTARIES — Stations	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Trichopteroidea	Hydropsychoidea	Hydroptilidae	Leptoceridae	Limnephilidae	Philopotamidae	Psychomyiidae	Stoneflies Nemouridae	Perlidae	Perlodidae	Pteronarcyidae	Mayflies Baetidae	Ephemeridae	Heptageniidae	Riffle Midges Orthocladiinae	Ballaenomidae Corydalidae	Alderflies Sialidae	Snipe Flies Rhagionidae	Gill Snails Pleurocerinae	CLASS II: Damselflies Coenagrionidae	Beetle Larvae Dryopidae	Elmidae	Gyrinidae	Psephenidae	Crayfish Astacidae	Scuds Gammaridae	Scuds Talitridae	Fingernail Clams Sphaeriidae	Snails Pulmonata	Flatworms Turbellaria	Worms Tubificidae	Midge Flies Chironomidae	Crane Flies Tipulidae	Black Flies Simuliidae	CLASS III: Leeches Hirudinea	Aquatic Worms Oligochaeta	Total Number	Total/Sq. Ft.	Variety of Forms	% CLASS I	% CLASS II	% CLASS III
East River	26	1																														120			120	240	240	2	0	50	50
East River	27	4	1	56					7		1			39		94			2	1	41	1		14		83				1	4		11			11	356	89	16	65	31	3
Piney Creek	53	2		171							1			18				1							1							8		31		184	92	7	77	23	0
Piney Creek	54	2		1																									11			118			474	803	401	3	0	41	59
* = trace amounts																																													

Table 4. COMPOSITION and CLASSIFICATION of GREENBRIER RIVER BASIN BENTHIC SAMPLES, 1964

GREENBRIER RIVER BASIN Stations	Station Number	No. of Sq. Ft. Samples	CLASS I																		CLASS II								III					
			Caddisflies Hydropsychidae	Glossosomatidae	Hydropsychidae	Hydroptilidae	Leptoceridae	Philopotamidae	Psychomyiidae	Rhyacophilidae	Stenopsyche Stenopsychidae	Perlidae	Perlodidae	Baetis Heptageniidae	Ephemerella Ephemerellidae	Heptagenia Heptageniidae	Isonychia Isonychiidae	Paraleptophlebia Leptophlebiidae	Siphlonurus Siphlonuridae	Gill Snails Pleuroceridae	Dragonflies Gomphidae	Damselflies Coenagrionidae	Beetle Larvae Elmidae	Psephenidae	Crayfish Astacidae	Scuds Gammaridae	Fingernail Clams Sphaeriidae	Snails Pulmonata	Flatworms Planariidae	Midge Flies Tendipedidae	Crane Flies Tipulidae	Black Flies Simuliidae	Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Variety of Form	% CLASS I	% CLASS II	% CLASS III
East Fork of Greenbrier	35	2			25							1		15	1	12			1	1			13	13						15	1		1	99	49	12	57	42	1
East Fork of Greenbrier	36	1																												21				21	21	1	0	100	0
West Fork of Greenbrier	37	2	3		10			1		4	1			7		18				1			10	11						4				70	35	11	64	36	0
Greenbrier River	38	2			1	1													2				1	4		5	5			72		137	6	215	117	11	2	95	3
Deer Creek	40	2												1		3								1						2		18		25	13	5	16	84	0
Greenbrier River	41	2		3	92							15		12		26				3	86		6	5				4		14			1	261	130	12	89	11	+
Greenbrier River	42	1																	1											270			23	294	294	3	+	92	8
Greenbrier River	42	1									1	4		6		4								2	1			35		49			31	129	129	8	12	67	21
Knapp Creek	43	2		1	2			1					1	6		26				2		1		8						4		27		79	41	12	49	51	0

GREENBRIER RIVER BASIN Stations	Station Number	No. of Sq. Ft. Samples	CLASS I																		CLASS II								III					
			Caddisflies Hydropsychidae	Glossosomatidae	Hydropsychidae	Hydroptilidae	Leptoceridae	Philopotamidae	Psychomyiidae	Rhyacophilidae	Stenopsyche Stenopsychidae	Perlidae	Perlodidae	Baetis Heptageniidae	Ephemerella Ephemerellidae	Heptagenia Heptageniidae	Isonychia Isonychiidae	Paraleptophlebia Leptophlebiidae	Siphlonurus Siphlonuridae	Gill Snails Pleuroceridae	Dragonflies Gomphidae	Damselflies Coenagrionidae	Beetle Larvae Elmidae	Psephenidae	Crayfish Astacidae	Scuds Gammaridae	Fingernail Clams Sphaeriidae	Snails Pulmonata	Flatworms Planariidae	Midge Flies Tendipedidae	Crane Flies Tipulidae	Black Flies Simuliidae	Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Variety of Form	% CLASS I	% CLASS II	% CLASS III
Greenbrier River	44	2			7							2		12		38	1	3		21		1	4	6				1		9			4	109	54	13	77	19	4
Greenbrier River	46	3			93		5	21				11		9	7	5				29			23	13				31		4		18		269	89	13	69	33	0
Howard's Creek	47	2						1				1		1									18	16	1	3		193	1	58			1	294	147	11	1	99	+
Greenbrier River	48	3			21			9				15			8	6	1			175		1	5	2		1		46				15	5	311	103	14	74	23	1
Greenbrier River	49	3			227		47	218	5			23		110	31	55	1		4	766			186	8			17	6		21		3	2	1730	577	18	86	14	+
Greenbrier River	50	2			49		10	3	16			11		15		99	2		1	53				4			1	58		10	3	3	3	122	61	17	71	25	1

+ = trace amounts

Table 5. COMPOSITION and CLASSIFICATION of BLUESTONE RIVER BASIN BENTHIC SAMPLES, 1964

BLUESTONE RIVER BASIN			CLASS I										CLASS II									III					
Stations	Station Number	No. of Sq. Ft. Samples	Caddisflies Hydropsychidae	Hydropsilidae	Leptoceridae	Stoneflies Perlidae	Mayflies Baetidae	Baetidae	Ephemeridae	Heptageniidae	Dobsy Flies Nigronidae	Gill Snails Goniobasidae	Beetle Larva Dytiscidae	Psephenidae	Sandbugs Leptoceridae	Snails Valvatidae	Snails Pulmonata	Flatworms Turbellaria	Midge Flies Tendipedidae	Horse Flies Tabanidae	Black Flies Simuliidae	Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Variety of Forms	% Intolerant	% Tolerant	% Very Tolerant
Bluestone River	29	3										22	29				9		36	25		350	471	157	5	5	21	74
Bluestone River	30	3																	3			1197	1200	400	2	0	*	99
Bluestone River	31	2					3								1	2	2		363		187		558	279	6	*	99	0
Bluestone River	32	2	41			3	22	16	42			16	70						4			1	215	107	9	65	34	*
Brush Creek	33	2															2		112		3	11	128	64	4	0	91	9
Bluestone River	33a	1	21	19	2	3	26	9	32	1	12		5	7				1	11			1	150	150	14	83	16	*

* = trace amounts

Table 6. COMPOSITION and CLASSIFICATION of GAULEY RIVER BASIN BENTHIC SAMPLES, 1964

GAULEY RIVER BASIN			CLASS I													CLASS II								III					
Stations	Station Number	No. of Sq. Ft. Samples	Caddisflies Philopotamidae	Ephemerellidae	Leptoceridae	Hydropsychidae	Stoneflies Perlidae	Mayflies Heptageniidae	Baetidae	Ephemeridae	Dobsy Flies Nigronidae	Riffle Beetles Dryopidae	Alderflies Sialidae	Helicopsychidae Coryphoridae	Gill Snails Goniobasidae	Dragonflies Gomphidae	Damselflies Coenagrionidae	Beetle Larva Dytiscidae	Psephenidae	Crayfish Astacidae	Polycentropodidae Polycentropus	Pleuroceridae Goniobasis	Midge Flies Tendipedidae	Crane Flies Tipulidae	Black Flies Simuliidae	Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Variation of Forms	% CLASS I	% CLASS II	% CLASS III
Williams River	57	2	6			103	12	4	21			3			2			41					7	8	1		208	104	11	73	27	0
Cranberry River	59	2	1	1	2	7	1	2	10	6			1	1	1			5		1			26			4	69	34	15	47	47	6
Cherry River	60	2				27		42	29	1	6			1	1			17	11	1			5		2		143	71	12	75	25	0
Meadow River	62	3				1		5	13	5			4					25				10	27	1		72	163	54	10	17	38	44
Meadow River	63	2			2			8	25						1		1						7	1			45	22	8	80	20	0
Gauley River	58	3	5					1	5	3						1		4				11	412			3	446	148	9	4	96	*
Gauley River	61	2						4	24												1		3				32	16	5	87	13	0
Gauley River	64	2	2			89	4	8	77						3			12									195	97	7	94	6	0

* = trace amounts

Table 7. COMPOSITION and CLASSIFICATION of ELK RIVER BASIN BENTHIC SAMPLES, 1964

ELK RIVER BASIN Stations	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Rhyacophilidae	Hydropsychidae	Hydroptilidae	Philopotamidae	Psychomyiidae	Rhyacophilidae	Stoneflies Nemouridae	Perlodidae	Perlidae	Mayflies Baetidae	Heptageniidae	Snipe Flies Rhagionidae	Helgrammites Corydalidae	Gill Snails Pleuroceridae	CLASS II: Damselflies Coenagrionidae	Dragonflies Gomphidae	Aquatic Sowbugs Asellidae	Dance Flies Empididae	Beetle Larva Dryopidae	Elmidae	Perlodidae	Crayfish Astacidae	Fingernail Clams Sphaeriidae	Snails Pulmonata	Black Flies Simuliidae	Midge Flies Tendipedidae	Crane Flies Tipulidae	III: Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Varieties of Forms	% CLASS I	% CLASS II	% CLASS III
Elk River	74	2	1	10				2	20			18	27	2								10	3					6	3	2	101	52	12	77	21	2
Back Fork of Elk River	75	2	1	66			1	3	1	1	10	12		2			2				2	4	1	1				2	16	1	144	72	16	81	19	+
Elk River	76	2		71	5		2			6	5	35							1	4		2						30		6	120	60	11	64	31	5
Right Fork of Sally River	78	1		6					4		2	3								1						1		10			27	27	7	55	45	0
Left Fork of Sally River	79	1		1					8		2	30						1		2				1				5			50	50	8	82	18	0
Elk River	82	2		25	36				5	20	6	15					1					1		2		1	12	83		3	210	105	13	51	48	1
Birch River	83	1		18		29			15		22	10					4					5						6	1		140	140	9	89	11	0
Elk River	84	3		12	7	11			38	5	9	30			1		2			1		4				1	1	14	2	2	140	46	16	81	18	1
Elk River	86	3		32	2	10	1		3	16	7	6			1	4				1		3				1		2		17	105	38	15	76	7	17

ELK RIVER BASIN Stations	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Rhyacophilidae	Hydropsychidae	Hydroptilidae	Philopotamidae	Psychomyiidae	Rhyacophilidae	Stoneflies Nemouridae	Perlodidae	Perlidae	Mayflies Baetidae	Heptageniidae	Snipe Flies Rhagionidae	Helgrammites Corydalidae	Gill Snails Pleuroceridae	CLASS II: Damselflies Coenagrionidae	Dragonflies Gomphidae	Aquatic Sowbugs Asellidae	Dance Flies Empididae	Beetle Larva Dryopidae	Elmidae	Perlodidae	Crayfish Astacidae	Fingernail Clams Sphaeriidae	Snails Pulmonata	Black Flies Simuliidae	Midge Flies Tendipedidae	Crane Flies Tipulidae	III: Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Varieties of Forms	% CLASS I	% CLASS II	% CLASS III
Big Sandy Creek	87	1		11		5	2		5				1									4			1		2	8			39	39	9	61	39	0
Elk River	88	2									1					3										1		8		16	29	14	5	13	31	55
Elk River	90	2																												126	126	63	2	0	0	100

+ = trace amounts

Table 8. COMPOSITION and CLASSIFICATION of COAL RIVER BASIN BENTHIC SAMPLES, 1964

COAL RIVER BASIN Station	Station Number	No. of Sq. Ft. Sampled	Caddisflies Trichoptilidae	Polycentropidae	Psychomyiidae	Hydropsychidae	Stenonema Heptageniidae	Perlodidae	CLASS I Rhyacophilidae Glossosomatidae	Brachycentridae	Dicosmoecus Limnephilidae	Helicopsychidae Helicopsychidae	Alderflies Sialidae	Dobsonflies Corydalidae	Stenonema Heptageniidae	Isonychia Heptageniidae	Baetis Leptohyphidae	CLASS II Hydropsilidae	Cheumatopsyche Hydropsilidae	Simulium Simuliidae	Blepharicera Blephariceridae	Midges Chironomidae	CLASS III Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Variables of Fauna	% CLASS I	% CLASS II	% CLASS III
Marsh Fork	96	2				240	24		24				1					2				24		335	167	6	95	5	0
Clear Fork	95	1																						0	0	0	0	0	0
Coal River	96	2	7			8	2	1											2	1		4		25	13	7	79	20	0
Coal River	99	2	7		1		2						2			4			1	1		92		110	55	8	11	86	0
Coal River	101	2	2		1	21			4		2					12				2	1	11	1	58	29	10	53	45	2
Pond Fork	106	1				3																7	12	12	12	3	*	*	0
Pond Fork	106	2				1							1		1					1				4	2	4	*	*	0
Pond Fork	107	2				13							2			9						4		28	14	4	54	46	0
Spruce Fork	108	2	2			58		1											1		1	14		79	38	6	77	23	0
Little Coal River	109	2	10		2	38		2			4		2		6		7		12			30	8	171	85	11	51	44	5

COAL RIVER BASIN Station	Station Number	No. of Sq. Ft. Sampled	Caddisflies Trichoptilidae	Polycentropidae	Psychomyiidae	Hydropsychidae	Stenonema Heptageniidae	Perlodidae	CLASS I Rhyacophilidae Glossosomatidae	Brachycentridae	Dicosmoecus Limnephilidae	Helicopsychidae Helicopsychidae	Alderflies Sialidae	Dobsonflies Corydalidae	Stenonema Heptageniidae	Isonychia Heptageniidae	Baetis Leptohyphidae	CLASS II Hydropsilidae	Cheumatopsyche Hydropsilidae	Simulium Simuliidae	Blepharicera Blephariceridae	Midges Chironomidae	CLASS III Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Variables of Fauna	% CLASS I	% CLASS II	% CLASS III
Little Coal River	110	2	5	8	3	178			27				5	2				1			5	11	18	1	264	132	12	86	13	*
Coal River	111	2	9	1	2	56		1	18	1				1		1	3				1	1	4		119	59	13	92	8	0
Coal River	112	2																				14[3]	40	80	160	80	3	0	33	67

* = trace amounts
1 = ceratopogonidae
2 = nematode

Table 9. COMPOSITION and CLASSIFICATION of POCATALICO RIVER BENTHIC SAMPLES, 1964

POCATALICO RIVER Station	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Hydropsychidae	CLASS II: Dragonflies Gomphidae	CLASS II: Snipe Flies Rhagionidae	CLASS II: Beetle Larvae Elmidae	CLASS II: Mayflies Siphlonuridae	CLASS II: Midge Flies Tendipedidae	CLASS II: Snipe Flies Tipulidae	CLASS III: Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Varieties of Forms	% CLASS I	% CLASS II	% CLASS III
Pocatalico River	114	1		10		1	1	4	15	7		33	33	6	30	70	0
Pocatalico River	116	2	1	2	1				33	1		38	19	5	8	92	0
Pocatalico River	117	2							64	4	564	760	370	3	0	9	91
Pocatalico River	118	1													0	0	0

Table 10. COMPOSITION and CLASSIFICATION of KANAWHA RIVER BENTHIC SAMPLES, 1964

KANAWHA RIVER Station	Station Number	No. of Sq. Ft. Samples	CLASS I: Caddisflies Hydropsychidae	CLASS I: Caddisflies Rhyacophilidae	CLASS I: Riffle Beetles Elmidae	CLASS I: Mayflies Heptageniidae	CLASS I: Mayflies Ephemerellidae	CLASS I: Mayflies Leptophlebiidae	CLASS II: Beetle Larvae Psephenidae	CLASS II: Beetle Larvae Dryopidae	CLASS II: Dragonflies Gomphidae	CLASS II: Dragonflies Macromiidae	CLASS II: Mayflies Ephemeridae	CLASS II: Midge Flies Tendipedidae	CLASS II: Snipe Flies Tipulidae	CLASS III: Aquatic Worms Oligochaeta	Total Number	No./Sq. Ft.	Varieties of Forms	% CLASS I	% CLASS II	% CLASS III
Kanawha River	125	3														56	56	18	1	0	0	100
Kanawha River	126	3														651	651	217	1	0	0	100
Paint Creek	68	2				2						1			1		4	2	3	*	*	0
Cabin Creek	70	2		1					2						19	1	23	11	4	*	*	*
* = trace amounts																						

TABLE 11 Kanawha Basin Fish Kills, 1966

STREAM	NEAREST BENTHIC SAMPLING STATION	LOCATION	DATE OF KILL	OPERATIONS INDICATED AS RESPONSIBLE FOR KILL	ESTIMATED NUMBER OF FISH KILLED
Bluestone River	30	Bluefield, Va.	3-15-66	Food & Kindred Products	200
Pond Fork of Coal River	106	Van, W. Va.	5-10-66	Mining	180,000
Kanawha River	113	Nitro, W. Va.	6-11-66	Industrial	1,350
Greenbrier River	42	Marlinton, W. Va.	7-14-66	Tannery	300
Stroubles Creek	19	Blacksburg, Va.	8-4-66	Unknown	600
Cherry River	60	Fenwick, W. Va.	8-7-66	Mining	300
Poca River	116	Walton, W. Va.	9-66	Brine from Oil Wells	No Estimate
TOTAL					182,750

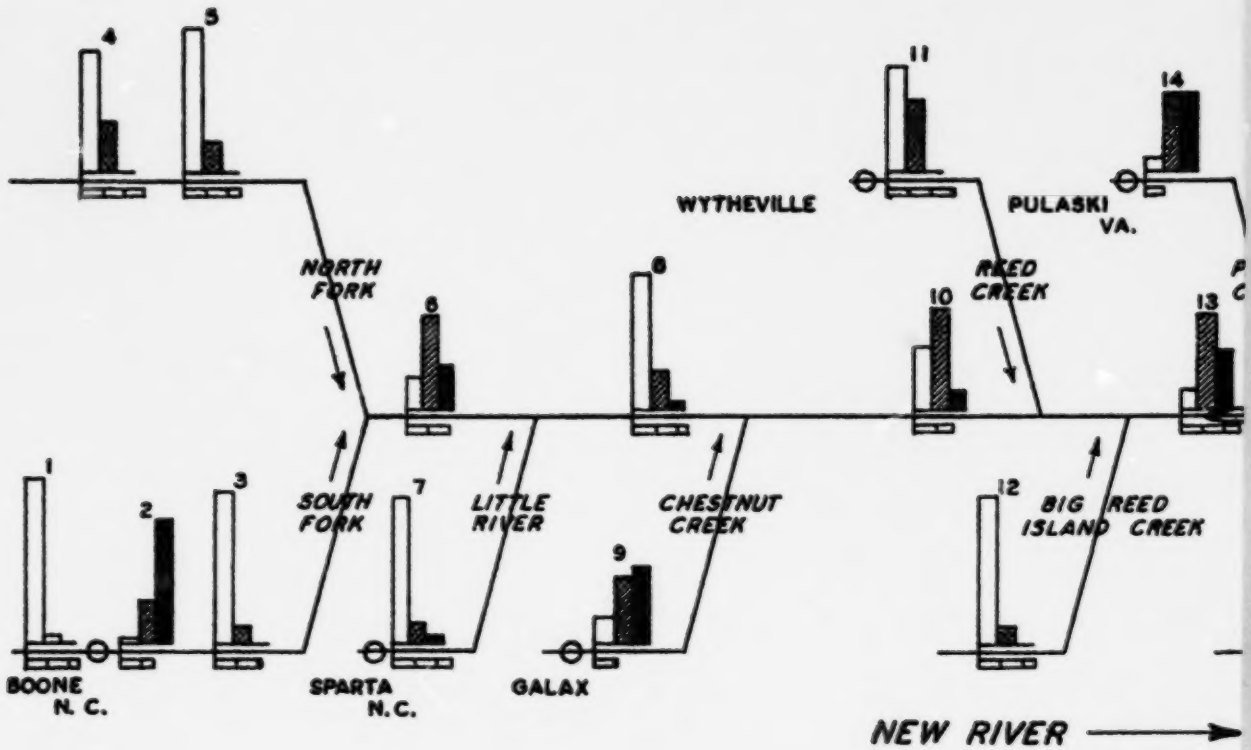
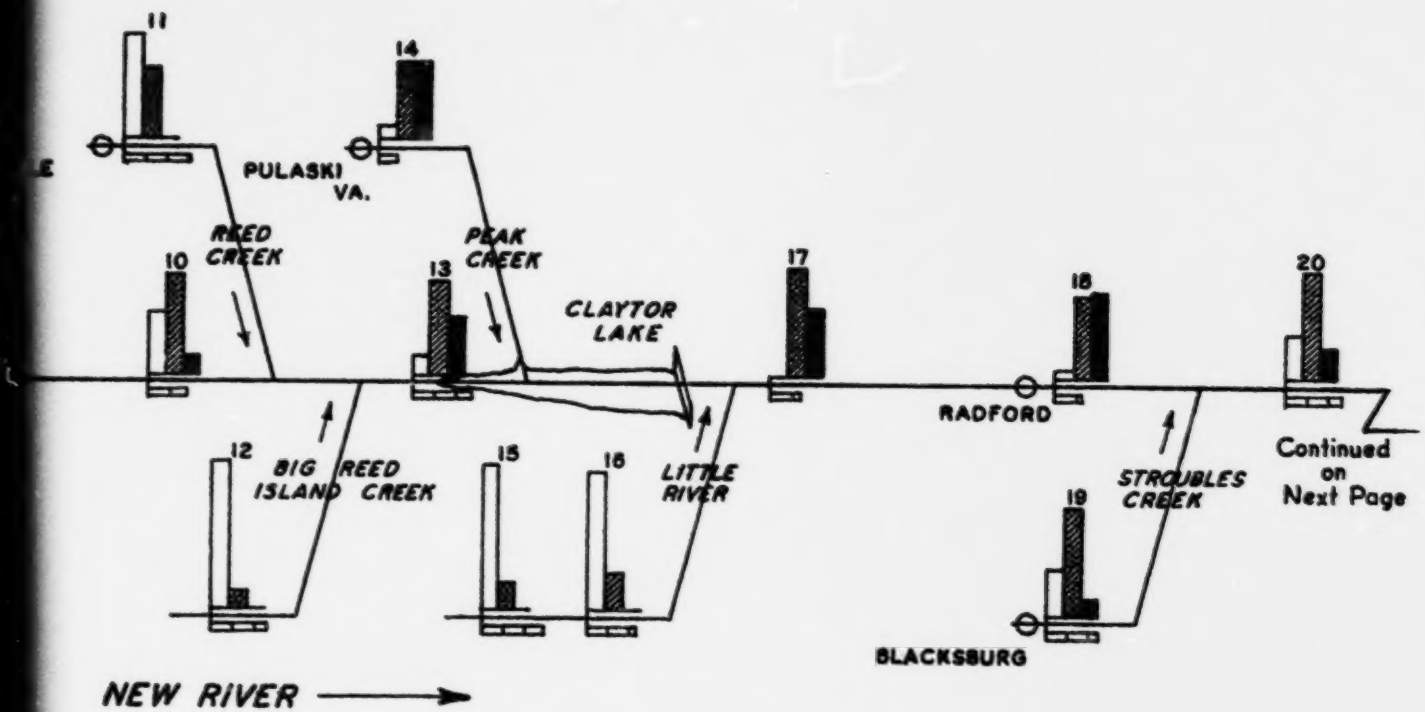
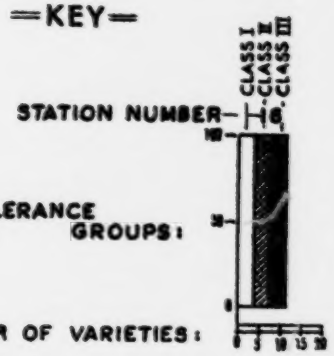


FIGURE 2. MAIN STEM NEW RIVER BASIN & MINOR TRIBUTA
Percentage Composition of Benthic Samples





BASIN & MINOR TRIBUTARIES
tion of Benthic Samples

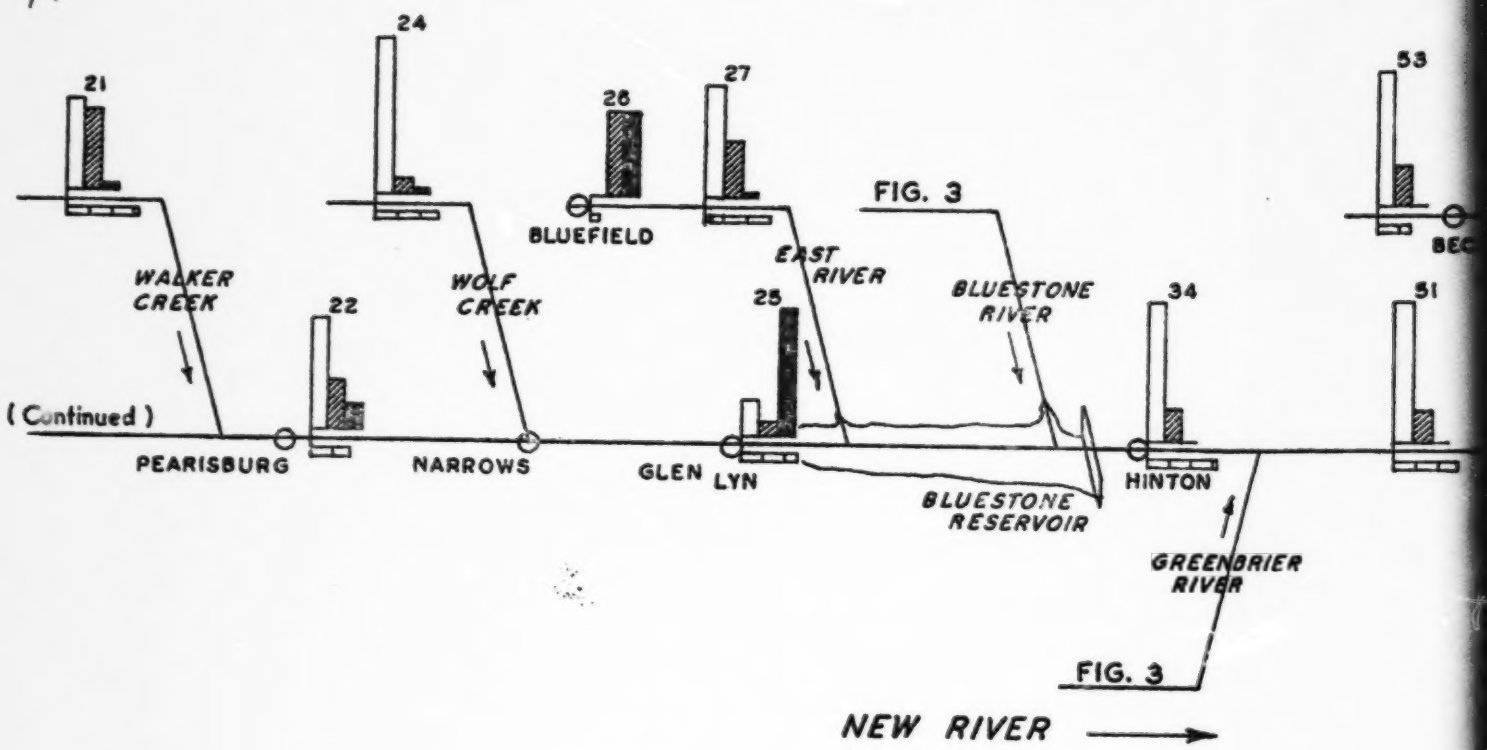
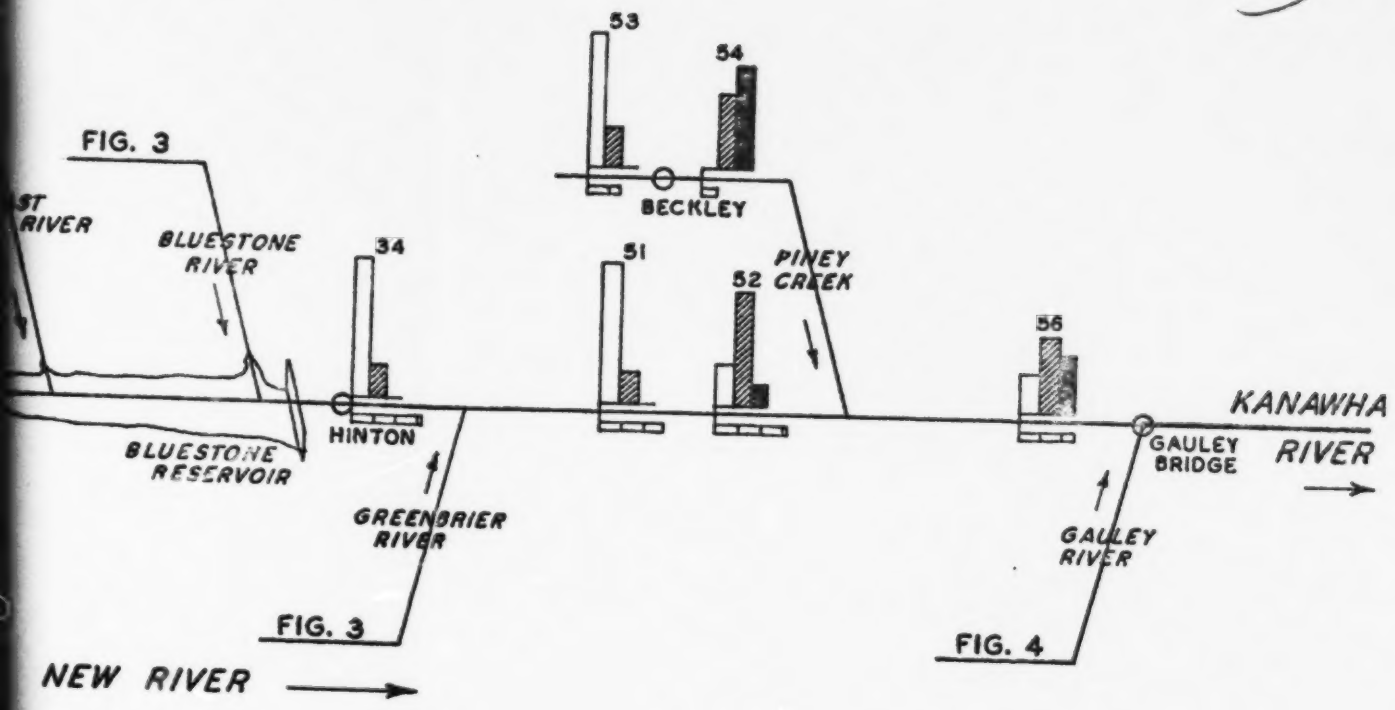
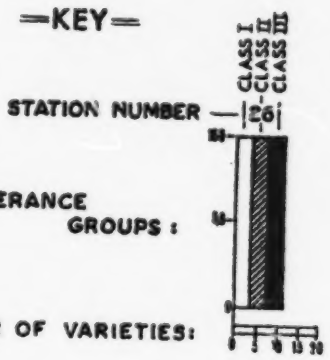


FIGURE 2a. MAIN STEM NEW RIVER BASIN & MINOR TRIBUTARIES
Percentage Composition of Benthic Samples



R BASIN & MINOR TRIBUTARIES
position of Benthic Samples



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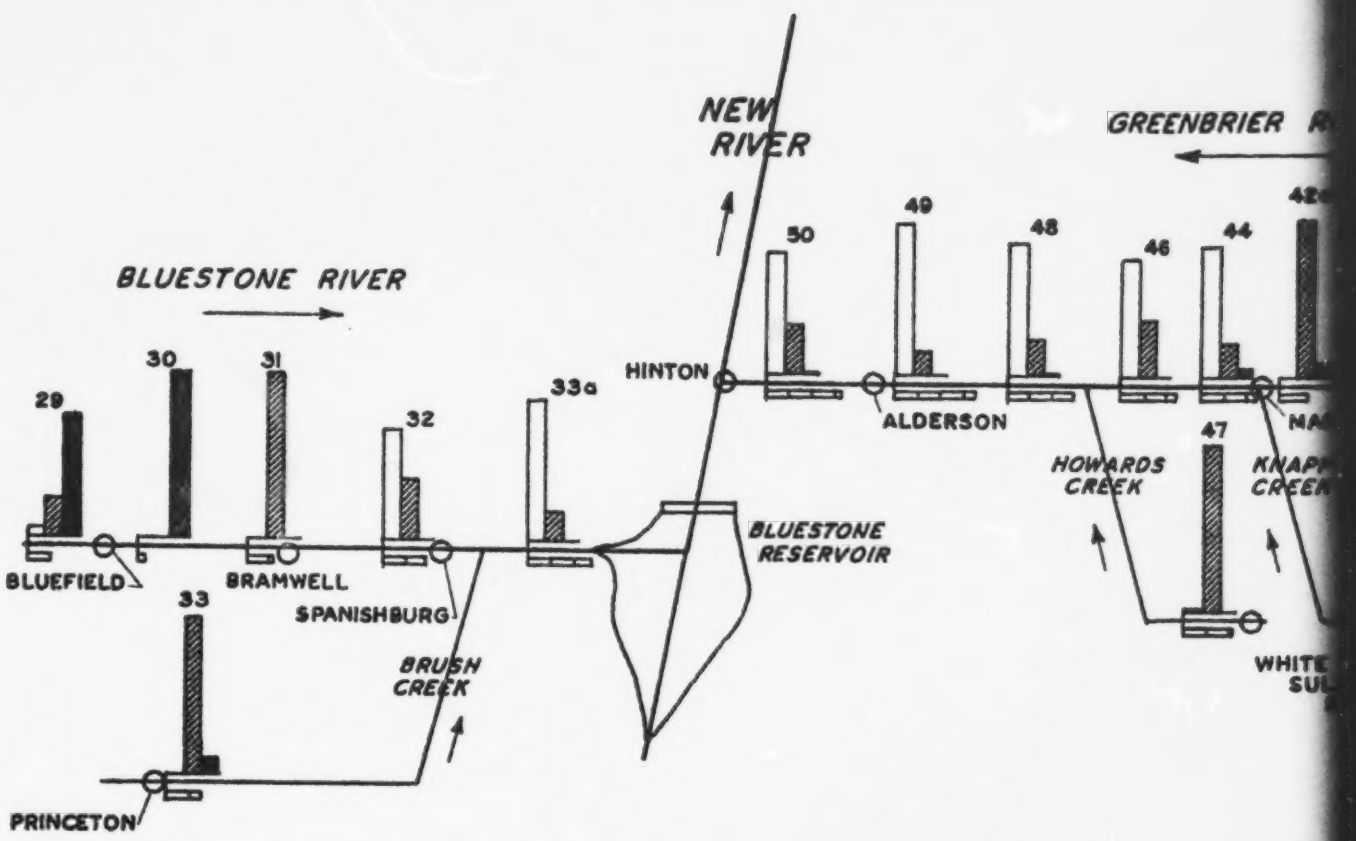
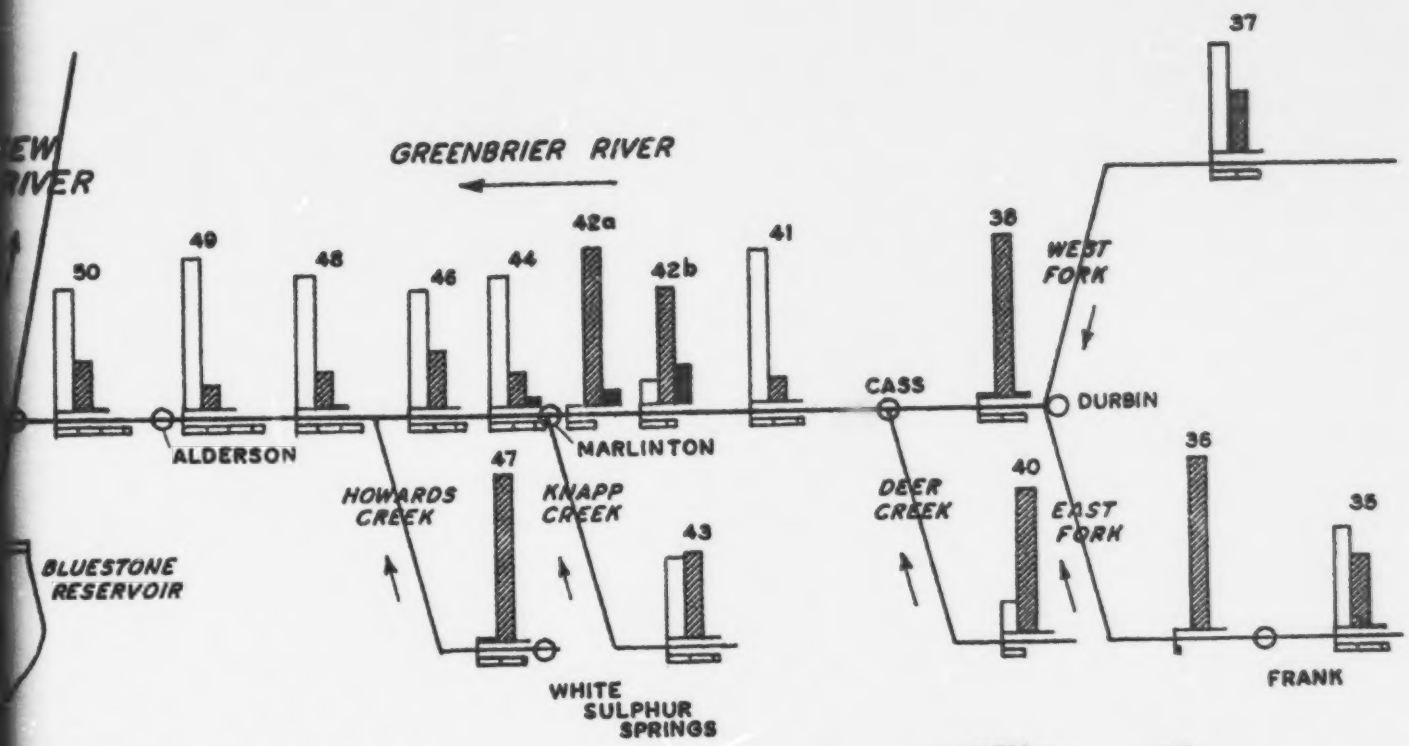
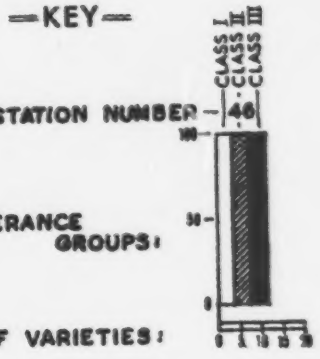


FIGURE 3. BLUESTONE AND GREENBRIER RIVER BASINS
Percentage Composition of Benthic Samples





GREENBRIER RIVER BASINS
nposition of Benthic Samples

A

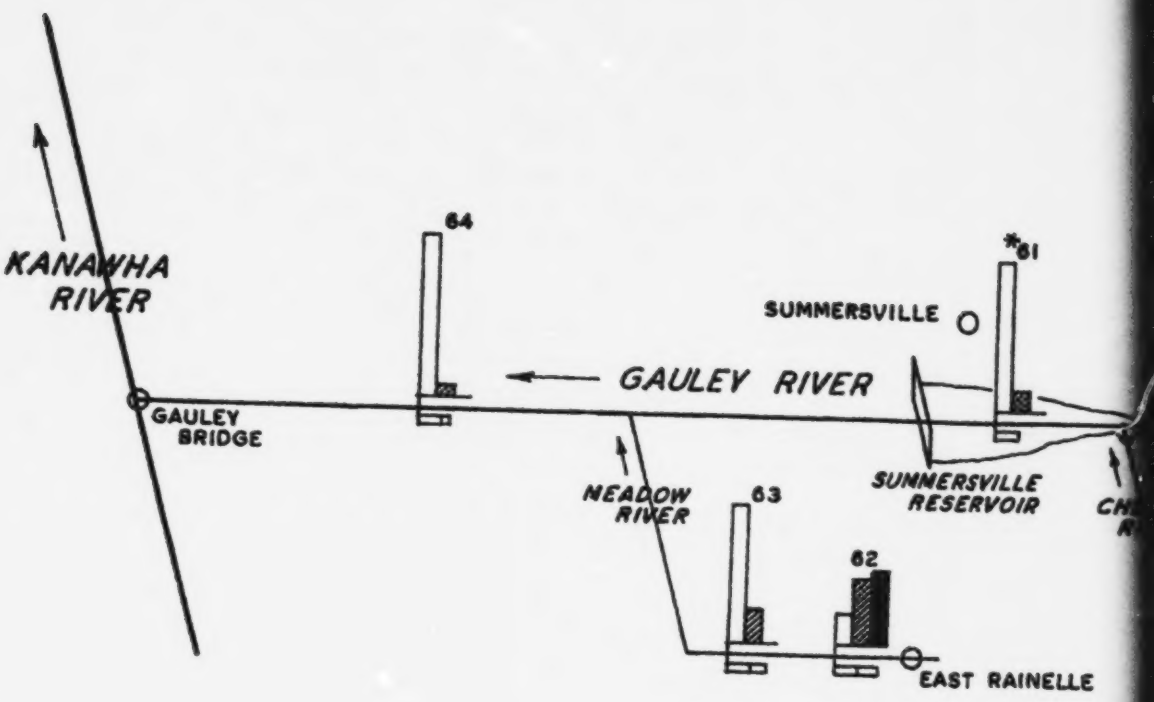
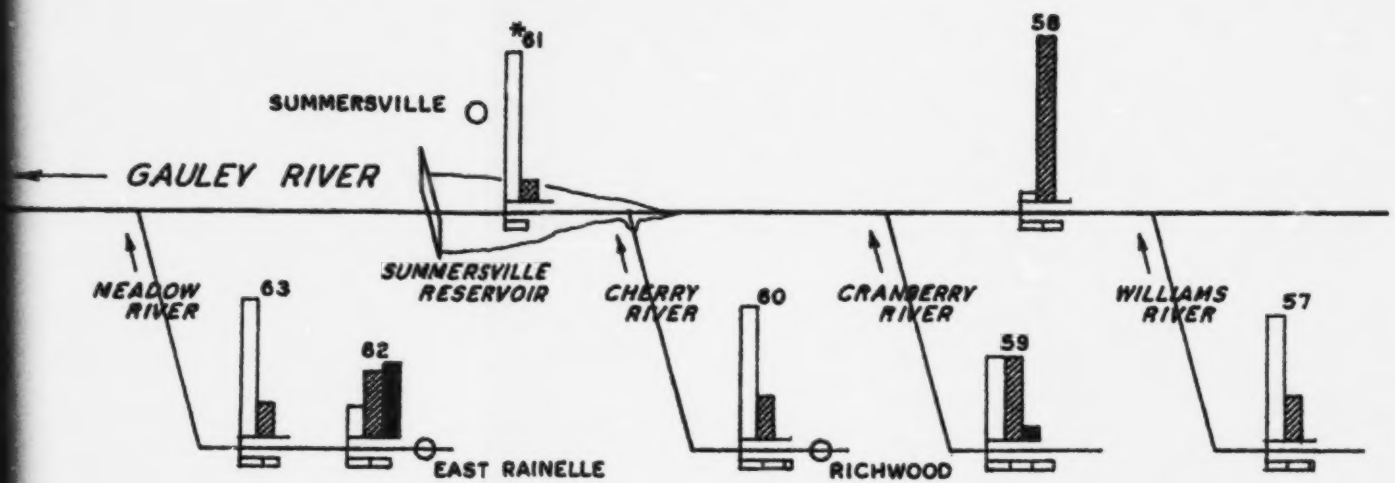
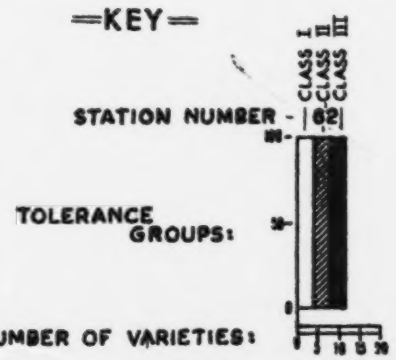


FIGURE 4. GAULEY RIVER BASIN
Percentage Composition of Benthic Samples





*61 - STATION SAMPLED PRIOR TO INUNDATION

GAULEY RIVER BASIN
Composition of Benthic Samples

A

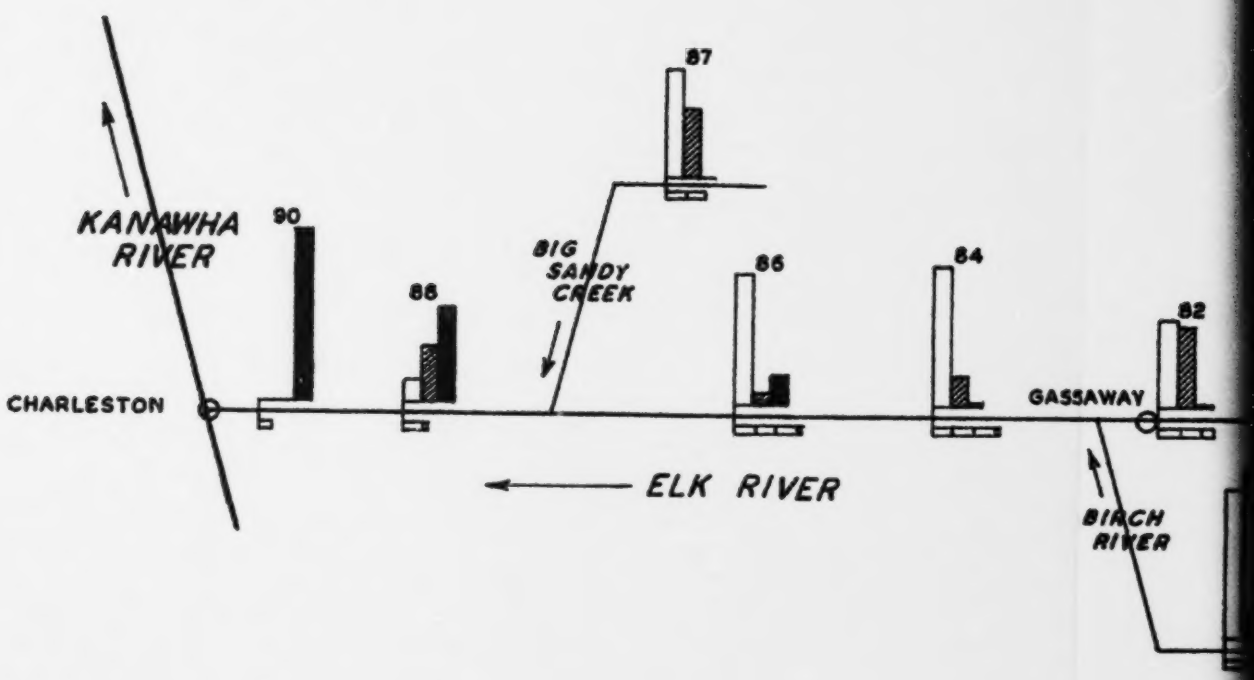
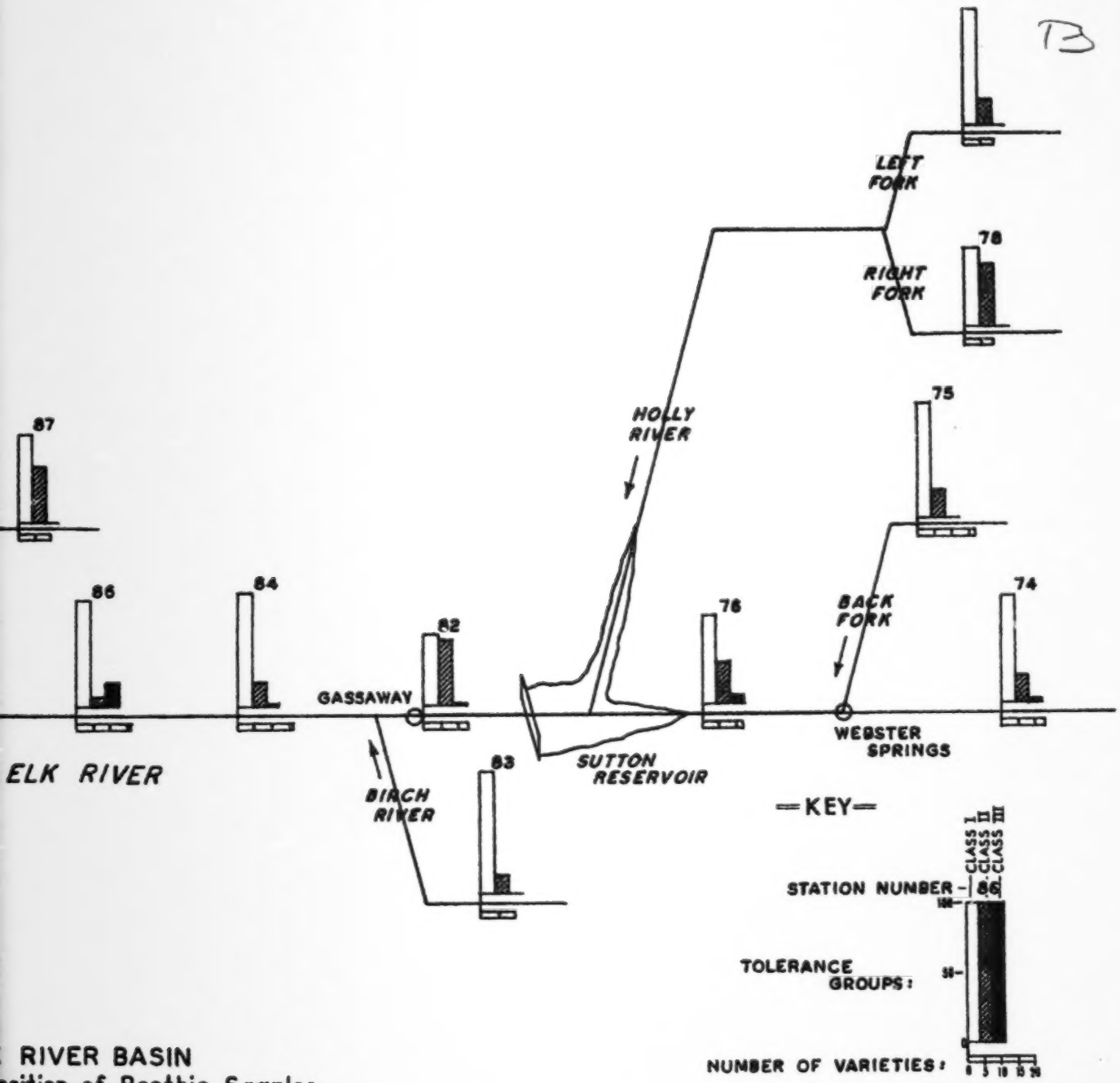


FIGURE 5. ELK RIVER BASIN
Percentage Composition of Benthic Samples

B



RIVER BASIN
osition of Benthic Samples

A

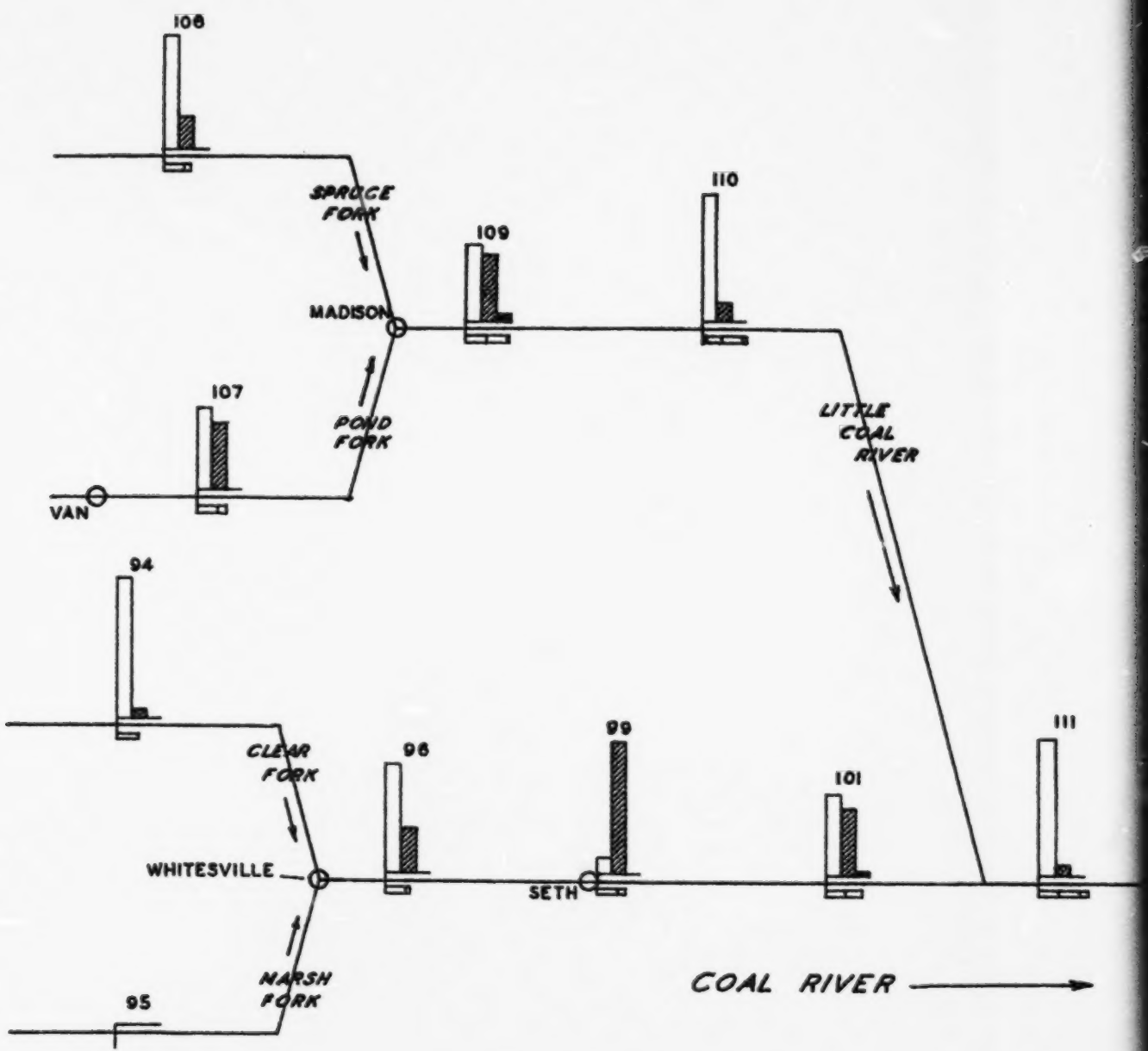
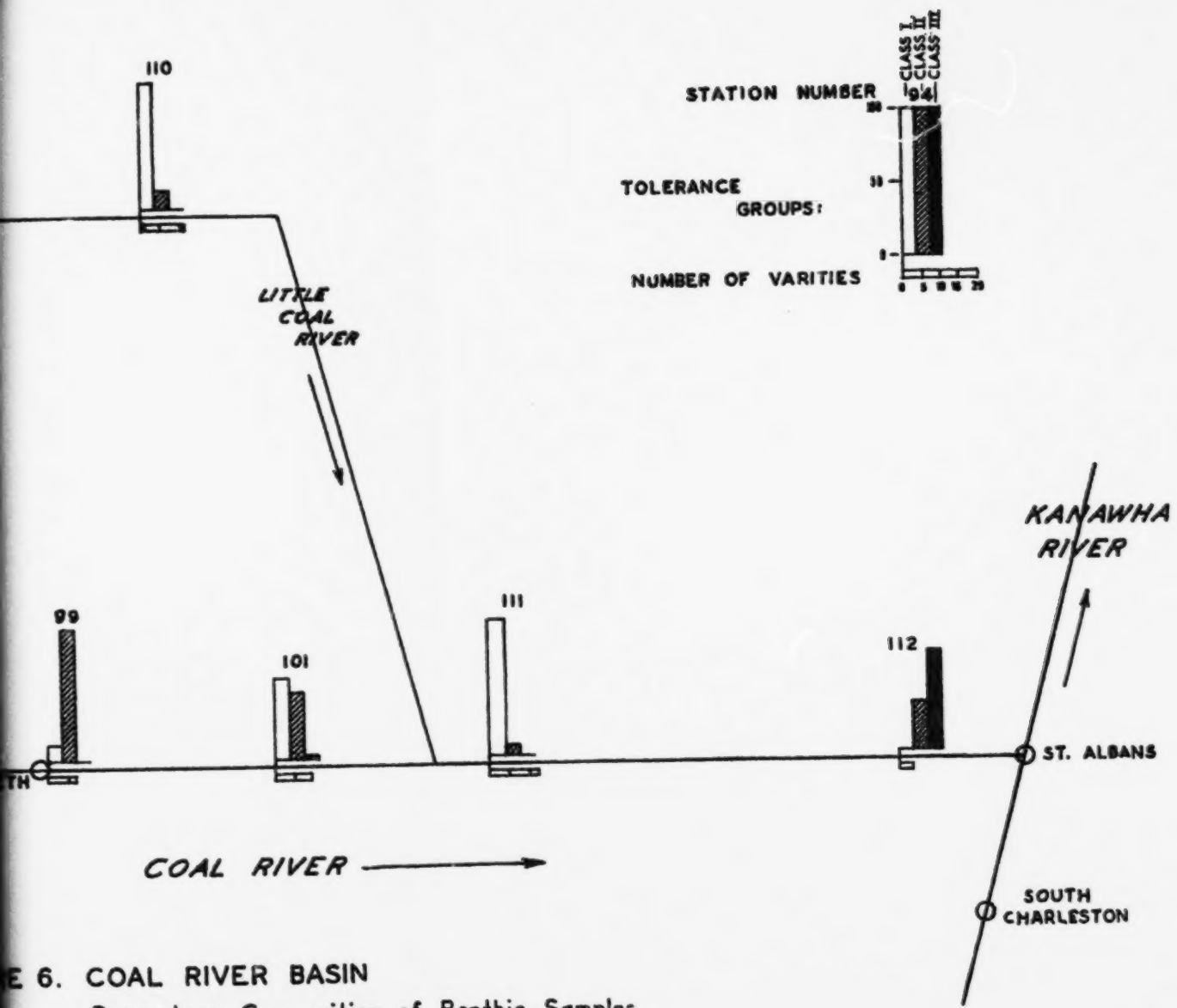


FIGURE 6. COAL RIVER BASIN

Percentage Composition of Benthic Sam



E 6. COAL RIVER BASIN
Percentage Composition of Benthic Samples

A

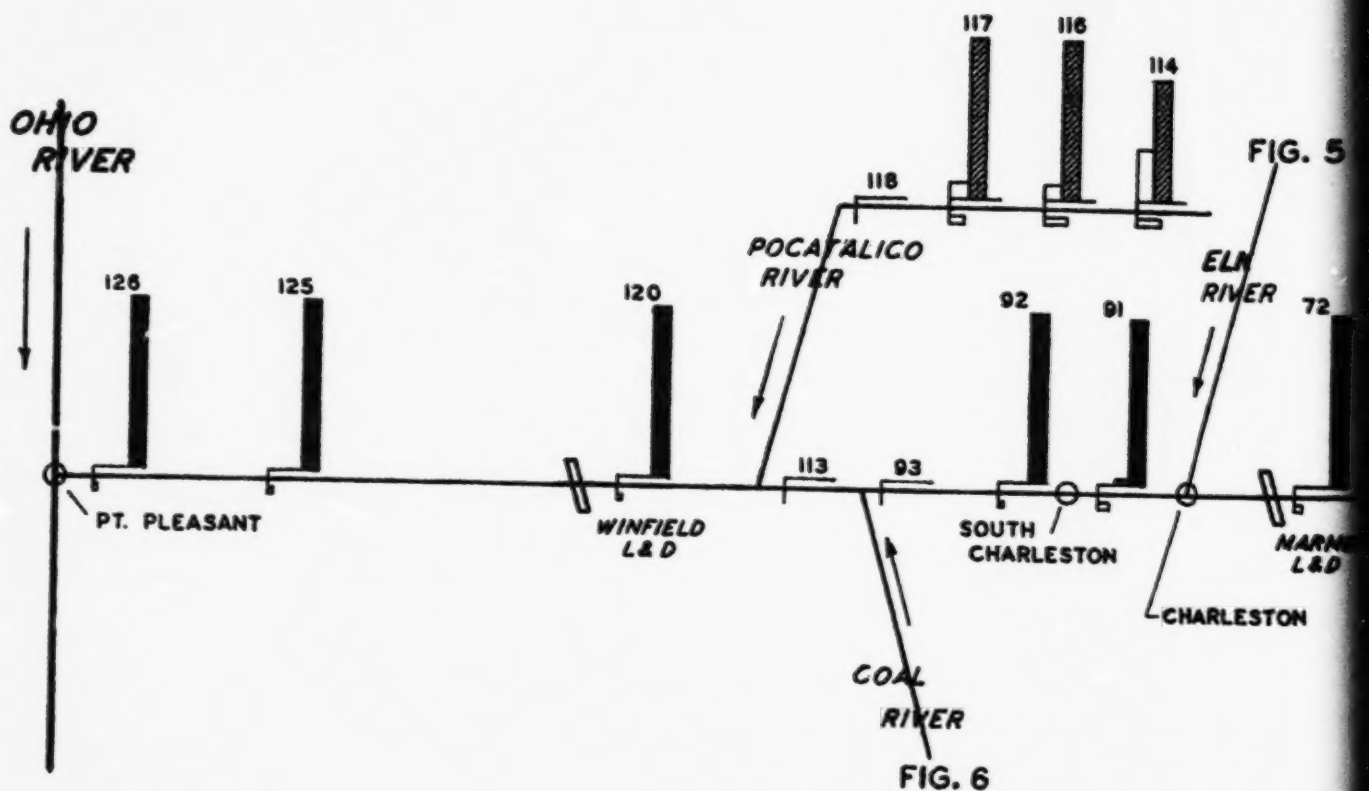
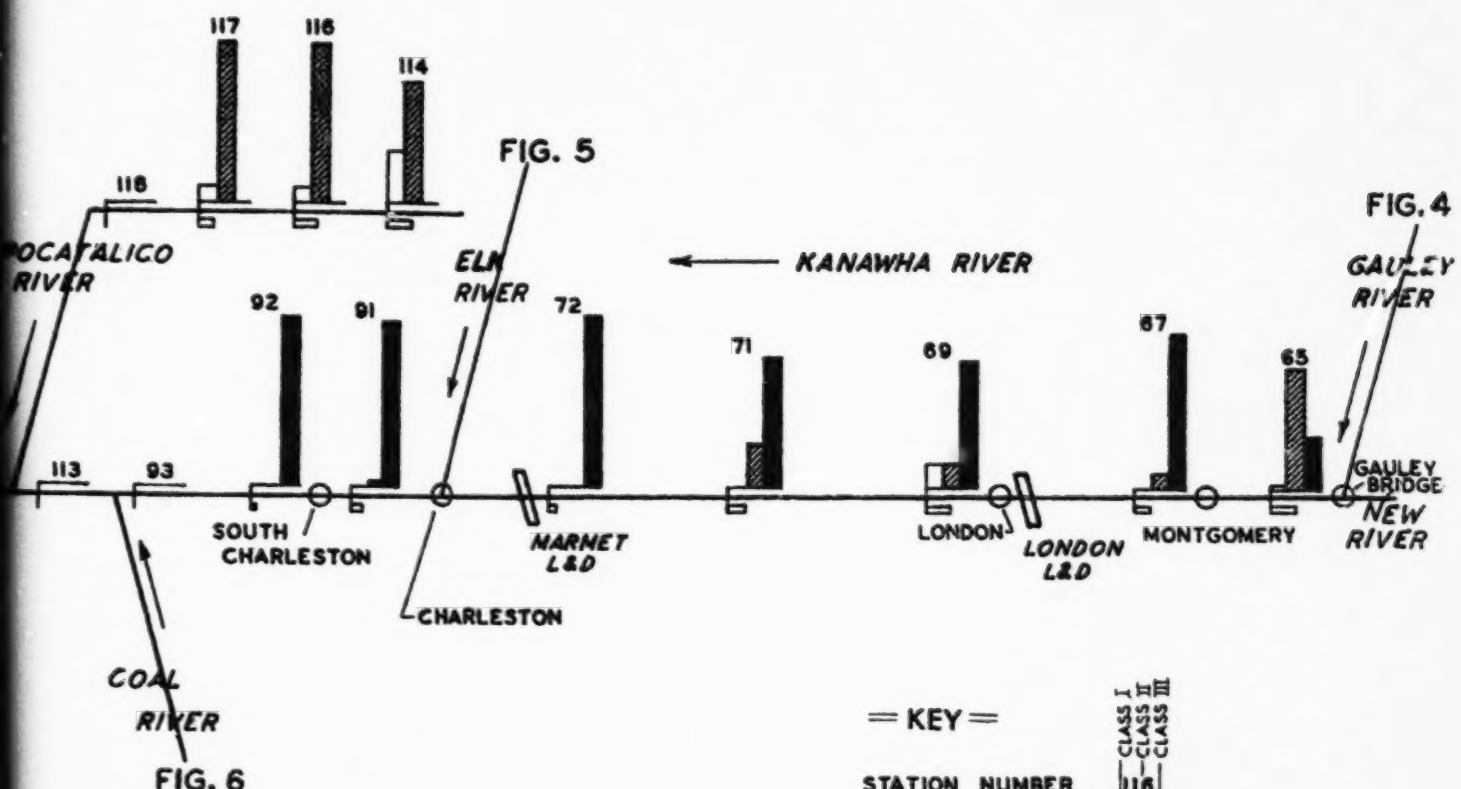
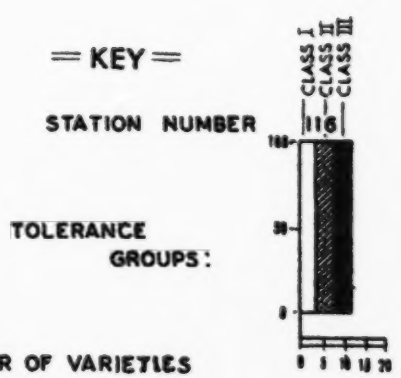


FIGURE 7. MAINSTEM KANAWHA RIVER BASIN
Percentage Composition of Benthic Samples

B





IVER BASIN
Samples

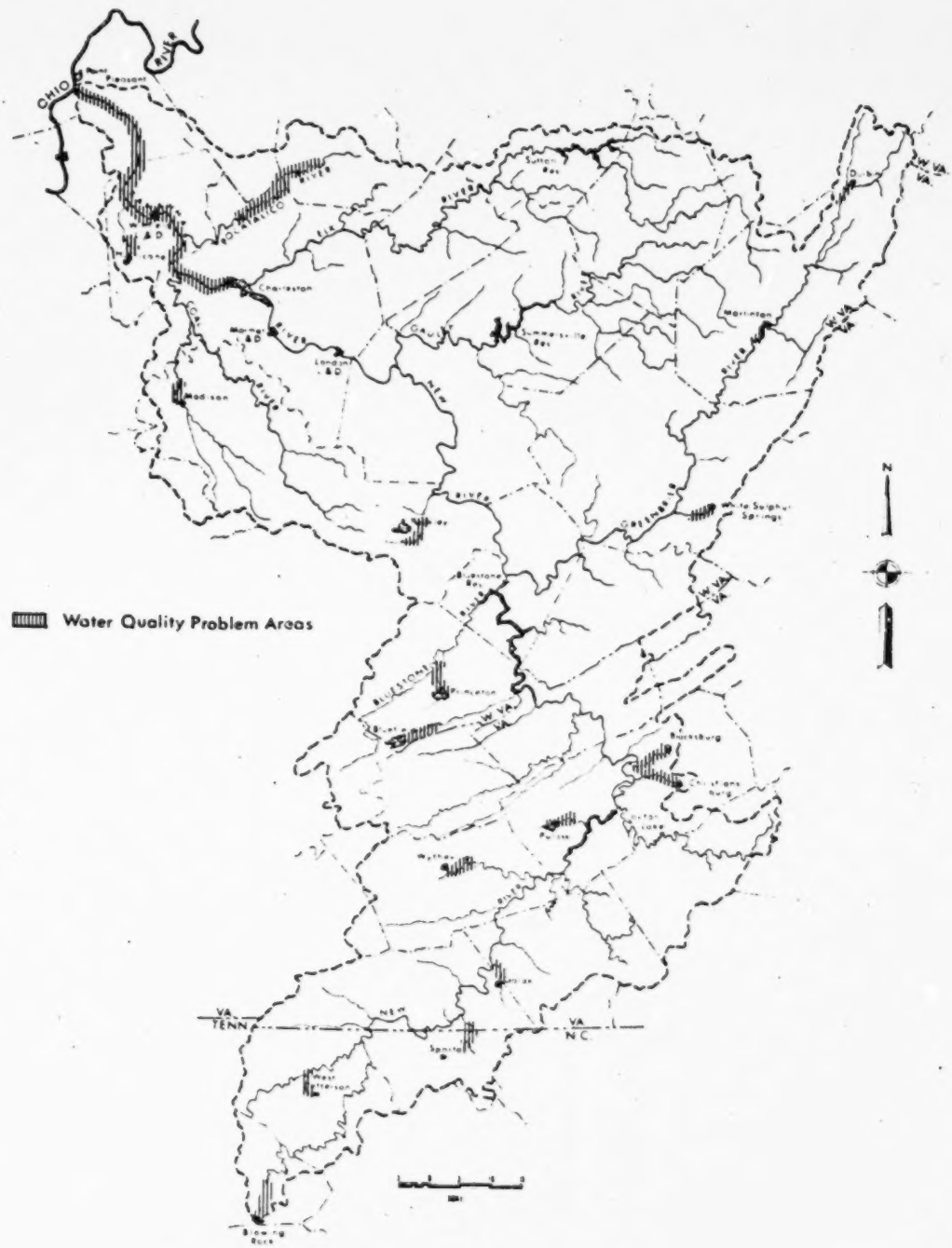


Figure 8. Water Quality Problem Areas in the Kanawha-New River Basin.

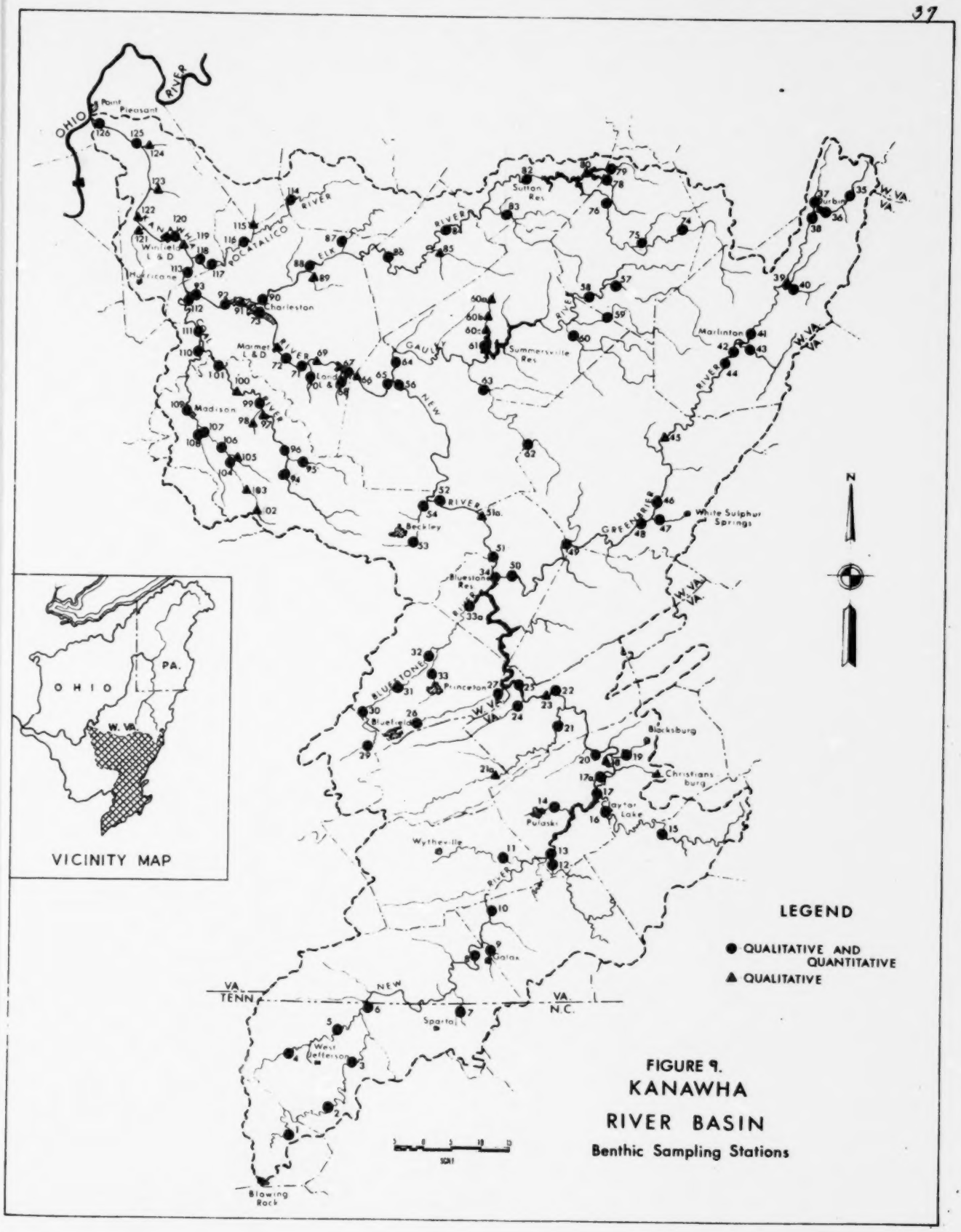


FIGURE 9.
KANAWHA
RIVER BASIN
Benthic Sampling Stations